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(Fire and Emergency Planning Directorate)

Fire Service Manual

Volume 1
Fire Service Technology, Equipment and Media

Communications and Mobilising

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Preface

The first edition Part 5 of the Manual of Firemanship dealing with the subject of communications was issued in 1954. It concluded "Fire Service communications are intimately related to an intricate field of electrical engineering, which includes telecommunications both by landline and wireless, which is in turn only a small part of the territory covered by electrical science".

The passage of time and advances in technology have changed every concept of fire service communications from those identified by the writers within the first edition of Part 5. The basic fire services' communications requirements have, however, remained unchanged and are identified in the 1947 Fire Services Act. This is still as relevant today as it was when first mandated to fire authorities in 1947, to "secure efficient arrangements for dealing with calls for the assistance of the fire brigade in case of fire and for summoning members".

To ensure that fire services' communications efficiency is maintained to the highest level requires the introduction of modern technology systems, coupled with frequent reviews to brigades' practises and procedures. Changes in equipment and procedures become inevitable, because either equipment becomes obsolete, or technical maintenance support is exhausted or overly expensive. New equipment often has advantages over what it replaces, in that it generally incorporates more functionality and flexibility, thus affording greater opportunities for changes in procedures and practises.

It is an impossible task to bring the reader fully up-to-date with the technology that is both available and continually evolving, or indeed to indicate that which may be available in the future. This book is written in non-technical terms and aimed primarily at covering the operational and functional communications requirements of the professional firefighter. This, by necessity, encompasses all the communicating elements from that of *"the originating caller to the incident's conclusion"* via the brigade Control, station call-out and Incident Command structures. The text, diagrams and symbols used, whilst not necessarily conforming to those in other technical publications, have been modified as appropriate to assist the reader. Those who require further technical detail must refer to other publications and technical sources which specialise in the area concerned.

It is anticipated that this book will be invaluable to brigade Communications Officers and all personnel who are or become intimately involved in the planning, procurement, implementation and operation of mobilising systems, communications systems, radio and fixed and mobile communications. As in Book 10 of the Manual of Firemanship, a great deal of emphasis has been placed upon planning principles, and the importance of clearly identifying both the operational requirements and the constraints associated with procurement processes. New technology solutions can be both implemented and beneficial if, as a result of a due planning process, they address and meet the needs and criteria of 'the user'. New technology should not, however, be seen as the driving force and the reason to change for changes sake. This is especially so in areas where an overall simpler solution could be adopted instead.

It is hoped that the information and advice contained within this book will help to ensure that the Fire Services' Communications and associated

systems will at least maintain and ideally improve their present standards of efficiency and reliability.

The Home Office is greatly indebted to all those who have contributed and assisted (by providing material and information) in the preparation of the edition.

This book replaces the Manual of Firemanship Book 10 Fire Brigade Communications and Mobilising.

Home Office
June 1998

Communications and Mobilising

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Chapter 1

Chapter 1 - Regulatory issues

1.1 H. M. Government

Members of Her Majesty's Government responsible for the fire service are:

Secretary of State for the Home Department. (England and Wales);

Secretary of State for Scotland; and
Secretary of State for Northern Ireland.

Parliamentary Under-Secretaries of State

(Fire and Emergency Planning, Prisons, etc.)

Director Fire and Emergency Planning

Her Majesty's Chief Inspectors of Fire Services

Central Government Responsibility for the Fire Service

While Fire Authorities have statutory responsibility for the provision of fire cover and exercise day-to-day control over activities of their fire brigades, the **Home Secretary** has a central responsibility for the efficiency of the fire service and is answerable to Parliament on fire policy. Assistance is given to Fire authorities by the Home Office in establishing standards and the provision of technical guidance.

In England and Wales, the Home Office Fire and Emergency Planning Directorate advises the Home Secretary on fire matters including the operational efficiency of the fire service and the enforcement of fire safety legislation. Fire Brigades are inspected by HM Fire Service Inspectorate. The Inspectorate also provides the technical resource for compilation of codes of practice and guides, to legislation for the benefit of Fire Brigades.

HM Chief Inspectors provide reports to the relevant Secretary of State.

Fire Service Funding

In England and Wales, fire services are provided either by County Councils or Combined Fire Authorities in the shire, and by joint Fire and Civil Defence Authorities in London and the former metropolitan counties.

Some funding is provided from central government as part of a composite revenue support grant made to local authorities, the remaining cost is collected through the revenue support mechanism of the council tax. The Fire Service, unlike the Police Service, receives no specific grant from central government.

The money distributed for the fire service (Standard Spending Assessments) is not ring-fenced within the total amount available to the local shire authorities (Total Standard Spending) and the shire fire brigade has to compete with other local authority services for its resources. The FCDAs have no other sources of funding. The Combined Fire Authority (CFA) is financed by contributions from its constituent authorities, who are required to meet their proportionate share of such expenditure.

Capital expenditure by fire authorities may be funded from borrowing, capital receipts (subject to certain rules), or from revenue expenditure. The Home Office sanctions borrowing for fire capital expenditure generally through the allocation of Basic Credit Approvals (BCAs) and Supplementary Credit Approvals (SCAs) for specific purposes.

The Central Fire Brigades Advisory Council

In England and Wales, except on discipline and conditions of service matters, the Home Secretary is advised in the discharge of his/her responsibility for fire by the Central Fire Brigades Advisory Council (CFBAC). This council was set up under Section 29 of the Fire Services Act 1947 and is normally chaired by a Home Office minister and includes representatives of the local authorities, the fire service and other interested organisations. A similar council advises the Secretary of State for Scotland.

The CFBAC is in turn advised by a number of standing committees, and ad hoc committees are also established from time to time to consider or review particular policies. By agreement between the Home Secretary and the Secretary of State for Scotland, these standing committees are joint committees which advise both the Council for England and Wales and the Council for Scotland.

The Chairman of the Central Fire Brigades Advisory Council is usually the Parliamentary Under Secretary of State with specific responsibility for fire service matters.

The subject matter in this section of the manual is dealt with by the **Joint Strategy Committee on Operational Practices and Technology.**

Fire Service communication issues are also discussed within the Chief and Assistant Chief Fire Officers' Association (CACFOA) committee structure.

- Communications and Computing Policy Committee (C&CPC) - at Chief Officer level.
- District Communications Working Parties - at Control and Communication Officer level.

Home Office 999 Liaison Committee

The Home Office organises and supports meetings of the 999 Liaison Committee, a forum which brings together representatives of the Emergency Authorities (EAs) - (Police, Fire, Ambulance and Coastguard), the Public Telecommunication Operators (PTOs) (fixed and mobile) and other organisations with an interest in the 999 service. These include HM Fire Service Inspectorate, The Scottish Office, OFTEL and the Department of Trade and Industry.

The Committee, which meets twice a year under the chairmanship of the Home Office, discusses issues and matters arising from the provision of the 999 public emergency call service. The Committee encourages liaison between the EAs and PTOs at a more local level and considers what mechanism might be introduced to resolve disputes between the EAs and PTOs. It has also introduced Codes of Practice and Memorandums of Understanding, covering such issues as methods of handling 999 emergency calls on the fixed and mobile telephone networks.

The 999 Liaison Committee was responsible for producing the 'Strategic Framework for Combating Malicious Hoax 999 Calls' issued as DCOL 9/96 (in Scotland as DFM 8/1996).

Any problems which need to be resolved are progressed through a spirit of co-operation and goodwill between the relevant parties; the 999 Liaison Committee has no statutory powers or authority.

The Joint Strategy Committee on Operational Practices and Technology receives regular update reports from the 999 Liaison Committee.

1.2 OFTEL

The Office of Fair Trading for Telecommunications, OFTEL, is the regulator - or 'watchdog' - for the UK telecommunications industry. It is headed by the Director General of Telecommunications. The Director General is appointed by the Secretary of State for Trade and Industry and the appointment usually runs for five years.

OFTEL was set up under the Telecommunications Act 1984. OFTEL regulates through monitoring and enforcing the conditions in all telecommunications licences in the UK, and initiates modifications to these licence conditions.

All telecommunications operators - such as BT, Cable & Wireless (formerly Mercury), local cable

companies, mobile network operators and the increasing number of new operators - must have an operating licence. These set out what the operators can - or must - do or not do.

Under the Telecommunications Act 1984, OFTEL has a number of functions.

These include:

- ensuring that licensees comply with their licence conditions;
- advising the Secretary of State for Trade and Industry on telecommunications matters and the granting of new licences;
- obtaining information and arranging for publication where this would help users; and
- considering complaints and enquiries made about telecommunications services or apparatus.

Under the Act, the Director General has a duty to carry out these functions, some of these duties include:

- ensuring that telecommunications services are provided in the UK to meet all reasonable demands for them (this includes emergency services, public call boxes, directory information services and services in rural areas);
- promoting the interests of consumers;
- ensuring that those providing services are doing so efficiently; and
- promoting research and development.

The Director General has extensive powers under the Telecommunications Act, particularly when enforcing or modifying licence conditions. He can direct licence holders to comply with a certain condition - or conditions - in their licences. If they continue to breach the same condition/s the Director General can make orders which are enforceable through civil action.

OFTEL is also responsible for administering the numbering scheme in the UK and allocates blocks of telephone numbers to operators. A separate Numbering Administration Unit within OFTEL deals with this.

OFTEL monitors developments overseas. Nowadays UK operators are international businesses and so are their major customers. OFTEL takes a global view and ensures that UK policies and decisions reflect international developments, they are also closely involved with telecommunications developments in the European Union.

OFTEL is a non-ministerial government department, and is, therefore, independent of ministerial control.

Each year the Director General is required to submit an Annual Report on the department's activities and those of the Monopolies and Mergers Commission (MMC) in the telecommunications area, to the Secretary of State. This is laid before Parliament.

Funding is provided by Parliament, but the cost is offset almost entirely by the licence fees paid in by the operators.

OFTEL staff are Civil Servants, and experts from consumer, business and industrial backgrounds. The Director General also has six Advisory Committees to advise him on telecommunications matters. The only one of these committees that has a direct relevance to the Fire Service is the Advisory Committee on Telecommunications for Elderly and Disabled People (DIEL).

One OFTEL proposal was the introduction of a BT 'Lifeline' service. This service which gives provision for 999/112 calls also allows incoming calls for a few pence a month. A change to the disconnection policy may include barring of outgoing calls as an alternative to disconnection, emergency calls could still be made.

1.3 Radio Frequency Management

'Frequency' management in the United Kingdom is an inter-departmental function of central government accountable to a cabinet committee. Two sub groups and a small secretariat are responsible

for the general radio frequency planning and assignment procedures on behalf of this committee.

The **Frequency Planning Group** is formed from representatives of all government departments and agencies involved with frequency management. It examines proposals from departments to ensure that applications are compliant with the terms and conditions set out in the International Radio Regulations (IRR) and are consistent with effective use of the available spectrum. From time to time it may agree to assign a service or application outside the terms defined in the IRR. In such cases the group must be satisfied that no harmful interference will result to services operating in accordance with the Radio Regulation Tables.

The **Assignment Panel** is broader based and includes representatives from Industry as well as government departments and agencies. The panel examines all proposals to use shared radio bands. Its primary responsibility is to ensure that no harmful interference results from the shared use of radio bands or to the dedicated bands which are allocated to various services/applications.

Radiocommunications Agency

The Radiocommunications Agency (RA) was established as an executive agency of the Department of Trade and Industry (DTI) on 2nd April 1990. Previously the RA operated as DTI's Radiocommunications Division.

The Agency is responsible for most civil radio matters, other than those of telecommunications policy, broadcasting policy and the radio equipment market. The main activities are:

- licensing the use of radio equipment under the Wireless Telegraphy Act 1949;
- investigating interference and enforcing the relevant legislation;
- representing United Kingdom interests in international meetings on radio spectrum management matters;
- seeking to ensure that all United Kingdom users, manufacturers and installers of radio equipment comply with the relevant European Union measures and with the relevant provisions of international agreements to which the United Kingdom is a party;
- developing policy for, and planning and regulating use of the radio frequency spectrum, the geostationary orbit and other orbits of telecommunications satellites by all non-government users of radio equipment in the United Kingdom except where otherwise agreed; and
- monitoring the radio frequency spectrum as an aid to its management, enforcement, and ensuring freedom from harmful interference.

Radio Investigation Service

The Radio Investigation Service (RIS) is the enforcement arm of the Radiocommunications Agency. Its aim is to ensure that authorised radio users can operate without undue interference. This is achieved by ensuring that licensed users adhere to the conditions under which they are authorised to operate and, if necessary, by taking legal enforcement action against those who operate radio equipment without regard to other authorised users.

The RIS has several roles:

- resolution of interference problems;
- inspection of installations at customer's premises; and
- help and advise with radio problems and offer a paid diagnostic service to commercial and domestic radio users.

The RIS inspects all Police and Fire Service radio installations as part of their work. This is to ensure compliance with the conditions of the radio licence. The RIS has indicated that it will contact users beforehand to arrange a convenient date and time for the inspection.

Role of the Home Office in Frequency Regulations and Management

The Home Office (Scottish Office in Scotland) participates in national frequency management in the United Kingdom, and is accountable to the Cabinet Office. These departments also provide representation through the RA in international frequency management fora.

The maintenance of inter-operability between individual users is a major operational requirement of both the Police and the Fire Service. This has a significant influence on radio scheme engineering and spectrum planning. Where an individual force or brigade propose changes to their radio schemes that are likely to affect the level of current inter-operability, the department takes advice from national user representatives before granting the necessary assignments.

Policy and Regulation

The Home Office Frequency Management Group assigns frequencies to its user services to meet specified operational requirements. Wherever possible, this takes account of national and international frequency management policies.

Home Office policy is promulgated to users in the form of "Radio Frequency Policy Statements". Separate series of policy statements are prepared for both the Police and for the Fire Service

These documents, which are classified as 'Confidential' under the Government Protective Marking Scheme, are sent to all Chief Officers of Police, and Fire Services, and to certain other interested parties such as the Radiocommunications Agency. The documents form the basis on which assignments are licensed and regulated.

Radio Frequency Policy Statements can include operational limitations on the use of channels where it is considered necessary to maintain the efficient use of the radio spectrum.

Type Approval

To provide the most efficient use of the available radio spectrum, and avoid undue levels of interference between systems, it is essential that all radio equipment meets minimum standards of performance. Type approval is a procedure which involves checking the technical characteristics of new equipment, or modifications to existing equipment, to ensure that the design meets these standards and is acceptable for licensing. Type approval is only intended to provide a means of examining an equipment's potential for causing or suffering radio interference. It is not an endorsement or recommendation of a particular device for operational use.

If transmissions other than those of the required frequency (Spurious transmissions) **are radiated by transmitters, then this is likely to cause interference to other radio receivers.**

For civil radio spectrum users, these performance standards are published in a series of specifications issued by the RA. Similarly, equipment used in Home Office bands must also meet certain standards to satisfy the conditions of the users' licence.

The Home Office sets its own standards of performance for equipment used in its bands. Currently, these are based, where possible, upon the appropriate MPT*, or European Telecommunications Standard Institute (ETSI), specification. Where there are no relevant specifications. Radio Frequency and Communications Planning Unit (RFCPU) publishes its own. These set out the cardinal points to which equipment must comply before it is considered for licensing. The relevant Home Office Radio Frequency Policy Statement should be consulted for advice on the type approval of equipment to be used in Home Office bands.

Only approved equipment is licensed under current regulations and users are advised to check the suitability of any apparatus before making a financial commitment. Use of non-approved equipment contravenes the conditions of the comprehensive radio licence held by each Police force, Fire Brigade or other user of channels in the Home Office bands. Separate additional approval is

* MPI is an abbreviation for Ministry of Post and Telecommunications. Although this Ministry no longer exists, the RA is still using the initials MPT plus a number to indicate their specification documents

required from the Civil Aviation Authority (CAA) for equipment used in aircraft.

Radio call-signs

The Home Office RFCPU is responsible for the allocation of call signs to all fire brigade radio schemes. The detailed allocation of identifying suffix letters and/or figures to individual units (mobiles, etc.,) is arranged locally. The call signs for all police and fire brigade radio schemes start with 'M2' followed by two letters which identify the particular radio scheme, e.g., M2FH. The use of call signs, and radio operating procedures generally, are dealt with in the Fire Service Training Manual. The basic call sign of a fire brigade is shown on the brigade radio licence.

Home Office Frequency Management Group

The Home Office Frequency Management Group (HOFMG) is part of the Radio Frequency and Communications Planning Unit (RFCPU). The Scottish Office regulates frequencies for Scotland.

The main functions of the Frequency Management Group are as follows:

- Regulation and management of the frequency bands allocated for Home Office user services in accordance with national and international policies.
- Assignment of frequencies to meet specific user requirements in the Home Office bands at HF, VHF, UHF and SHF.
- Preparation and maintenance of licence schedules for Home Office user services and maintenance of a database of all assignments in the Home Office bands.
- Represents the Home Office and its user services within the national frequency planning forum.
- Provides representation, through the Radiocommunications Agency, at international frequency management forums.
- Promulgation of policy regarding the use of the department's band allocations through the publication of a series of Radio Frequency Policy Statements.
- Represents Home Office user services on DTI and National committees i.e.. Civil and Land Mobile Committee (CLMRC) and Microwave Fixed Links Committee (MFLC).
- Technical assessment of applications to share Police and Fire Service hilltop and other sites, to determine the potential risk of inter-
- Assist Home Office user services with interference problems.

The Police and Fire Comprehensive Radio Licence

In accordance with the Wireless Telegraphy Act (1949) all users of radio frequencies **must** be licensed by the Secretary of State. The organisation responsible for issuing radio licences or authority to use frequencies is the Radiocommunications Agency.

The 'Police and Fire Comprehensive Radio Licence' has been designed to cover all Home Office managed frequencies assigned to a particular user. Any assignments that a user holds which are in civil bands will need to be licensed separately. The only exception is 'Citizen Band' (CB) channels which are covered by the Police and Fire Licence.

For the fire service the licensee referred to in the licence document is normally the Chief Fire Officer. Under the terms of the licence, the licensee shall only use the Fixed Stations and Mobile Stations to send and receive wireless telegraphy relevant to the operation of the fire services.

Private Contractor Access to Fire Assignments in the Home Office Bands

With reference to the relevant Home Office Radio Frequency Policy Statement, where private contractors are responsible for the provision and/or maintenance of Fire Service radio systems, their staff may

have access to certain Brigade frequency assignments and be required to use these for the purposes of test transmissions. The Home Office will authorise the use of such frequencies within the Brigade area by private contractors, subject to the prior agreement of the respective Chief Officer. Use of Brigade frequencies at service centres remote from the Brigade area may be permitted conditionally, but with prior approval from the Home Office Radio Frequency and Communications Planning Unit.

Such contractors will be required to hold a **Test and Development (T & D) Licence** relevant to each Brigade to whom they remain responsible. T & D licences, which cover the repair and servicing of radio equipment are issued by the Radiocommunications Agency, and are subject to renewal annually on payment of the appropriate fee. During the tendering stage, Brigades should ensure that private contractors are made aware of the requirement for their work to be covered by a separate T & D licence.

Licenses for other frequency bands

The Police and Fire Comprehensive Radio licence does not authorise use of any frequencies other than those in the Home Office frequency bands. It is, therefore, necessary to apply for a separate licence from the Radiocommunications Agency for each channel. A **separate licence fee is payable for each licence.**

Use of Radio Channels in an Emergency

No automatic right exists for any authority or person(s) to use any frequency not allocated to them. However, in specific circumstances, e.g., an emergency, or for carrying out tests associated with maintenance and repair activity, such authority may be prior issued in writing or verbally. If an emergency situation exists, such person(s) must, at all times, utilise correct voice procedures which specifically ensure that the call sign of the correct licensee is used with specific suffixes allocated to 'approved' external users.

Licence Schedule

The licence schedule consists of a number of pages relating to every base station site used (one per page), as well as all mobile and fixed equipment used within each brigade. The detail contained within the schedule relates to the technical parameters associated with every base station site used by the brigade and its mobile equipment, and the radio frequencies the equipment is authorised to use.

Examples are:

Transmit power - The maximum transmitted power is normally that which enables the user's operational requirement to be met. This limits the risk of interference to other users and allows re-use of channels; and

Height above ground - The height of the aerial above ground may have to be limited to that required to give the required coverage.

Chief Fire Officers who require additional radio frequencies on any equipment **must:**

(1) if access to a channel of a neighbouring brigade is required:

seek the permission of the relevant Chief Fire Officer, forwarding the approval response to RFCPU, for the frequencies and channel to be included on the schedule; and

(2) if access to any other Home Office managed channel is required:

obtain written agreement from RFCPU prior to implementation.

Local Authority Chief Fire Officers are authorised to allow access to VHF and UHF incident channels (used within their Authorities area) by any member, of any fire brigade, providing assistance with fires in accordance with Section 2 of the Fire Services Act 1947 or to secure the discharge of an authority's function under Section 12 of the Act, subject to the conditions set out in Radio Frequency Policy Statement FPS 16.

Interference to Home Office Frequency Assignments

The Home Office allocated radio spectrum is used exclusively for the assignment of frequencies for use

by emergency services, and other Home Office user radio systems. Thus, co-channel interference on the mobile channels is likely to be from another Police Force or Fire Brigade, as applicable. The bands used for VHF/UHF links are shared by both Police and Fire Brigades and interference could, therefore, be from either. Other users on a radio channel is one of the factors taken into account when assignments are made. However, during periods of high atmospheric pressure, co-channel interference from other users at a considerable distance may be experienced, due to enhanced radio propagation.

Emergency service radio schemes are often co-sited with other privately operated systems. Some of these prime sites are heavily used, and there is a consequent high risk of interference between schemes due to the generation of intermodulation products. Although steps are taken to avoid assigning frequencies that may cause interference to existing channels, the probability of intermodulation interference depends largely upon the standard of engineering at the site.

If interference is suspected of being generated from electrical or telecommunications apparatus operated by another user, the Radio Investigation Service should be informed. The RIS have details of all users at each site and are highly experienced at solving interference problems. The RIS do not normally levy a charge if the interference is caused by another user. However, if the investigation concludes that the interference was caused by a deficiency within a Police or Fire Brigade's own equipment, then a charged may be levied accordingly.

Where interference is thought to involve another Home Office assigned service, the Home Office Frequency Management Group should be informed immediately. Where no suitable engineering solution is possible, consideration will be given to the reassignment of one of the services involved.

Air/Ground Communications

The Police are making increasing use of aircraft, both rotary and fixed wing. The Home Office has access to two 25kHz bandwidth air/ground assignments in the military band area of highband VHF, both of which are available for Fire Service co-ordination with the police.

Fire Brigades are authorised to use one VHF simplex channel and three UHF simplex channels for air/ground use operating within the Home Office UHF band. Two of the UHF channels are contained within the 6 UHF 'Fire Incident" channels, namely channel 1 or 6.

Brigades may select Channel 1 or 6 for air/ground use but **not both.** The choice of channel adopted by each brigade MUST BE notified to RFCPU for recording on the brigade's radio licence. The third available channel is one allocated to the Police from the National UHF Channel Plan. This channel has been agreed by the Association of Chief Police Officers (ACPO), primarily to facilitate the safe landing of other emergency services aircraft on roads.

Brigades may occasionally have a need to communicate from air-to-ground or vice versa utilising the Police VHF or UHF channels. Before doing so, prior approval of the relevant Chief Constable must be obtained.

All equipment (regardless of channels used) in aircraft **must** comply with the technical parameters and approvals as laid down in Radio Frequency Policy Statement FPS 11.

The Home Office RFCPU recognises that for certain 'very specialised' radio equipment, it may not be practical for manufacturers to submit a production sample for independent testing. This equipment will usually be low powered and produced in very small quantities. The risk of interference to others is, therefore, considered to be very small. Under these circumstances, approval may be granted for use of the device in Home Office bands without the need for independent testing, provided the manufacturer or supplier submits satisfactory written evidence of the performance characteristics to RFCPU.

1.4 Home Office Communications Advisory Panel (HOCAP)

This panel was created as part of the Review of Radio Communications in the Police and Fire

Service. The recommendations of the review are now being taken forward in a project known as the Public Safety Radio Communications Project (PSRCP). HOCAP's role is to provide guidance to Police Forces and Fire Brigades, to assist them in making informed decisions when considering future investment in new radio communications systems during the PSRCP development programme. The principal aim is that this guidance should ensure that any expenditure incurred represents good value for money, and that essential operational needs continue to be met.

HOCAP's terms of reference are:

- To provide guidance on the provision of new or enhanced communications systems for police forces and fire brigades until the PSRCP is complete.

- To assist brigades in:

  (a) achieving value for money;
  (b) avoiding wasteful investment;
  (c) maintaining standards;
  (d) preserving national operating considerations; and
  (e) maximising radio spectrum efficiency.

- To receive regular information from the Project Board on the progress of the Development Programme.

- To promote the work of the Development Programme and the PSRCP to forces and brigades.

- To maintain, update and circulate Guidance Notes to forces and brigades.

The membership of HOCAP varies depending on which service has requested the meeting and the nature of the subjects to be discussed. Chairmanship of the meetings will be either the Head of Home Office F7 Division or the Head of RFCPLJ, as appropriate. Other members will be the Project Manager, the Senior Police or Fire Service Representative, and the Senior Technical Representative. In addition, Project Assurance Team members and specialist staff may be co-opted as necessary.

A series of HOCAP Guidance Notes has been circulated to Chief Officers, these are updated from time-to-timc and circulated as appropriate.

Site Sharing

Figure I.I Shared Police and Fire Service Site
(Photo: Bedfordshire and Luton Fire & Rescue Service

The Home Office VHF bands are used to support wide-area coverage schemes using dominant radio sites. Such sites are often shared with other users. These may be other Police forces or Fire Brigades as well as private users. Often the Police and Fire Brigade will have several radio channels covering one part of the operational area. At each site, therefore, several transmit and receive frequencies from the same and different bands will be in operation.

The Home Office Frequency Management Group (FMG) offers a free service which can advise Police forces and Fire Brigades on the frequency compatibility of site sharing applications. FMG utilises specialist software to predict the spurious signals that may be generated when several transmitters operate on the same site. Some of the spuri-

ous signals may cause interference to co-sited base receivers or to mobiles which may be close to the site.

When considering site sharing applications, Communications Officers are strongly advised to seek assistance from their engineering advisors on the likely wind loading of the additional aerials and the resultant overall wind load on the mast. The overall capacity of the power supply to the site also needs to be assessed. Further advice can be found in the relevant Policy Statement on site sharing.

Retained Firefighter Alerter Systems

Fire Alerter systems used by Fire Brigades operate on a 25kHz bandwidth FM alerter channel in the VHF highband portion of spectrum.

The Home Office RFCPU allocate the alerter tones to brigades. The country has been divided into hexagonal cells 50 km across, with each cell being divided further into 127 smaller cells with each smaller cell being 5 km across. Seven codes are allocated to each smaller cell, making a total of 889 codes. Fire stations are allocated codes on the basis that the minimum reuse distance is 50kms. All equipment must be type approved by RFCPU.

Licences allowing Fire Brigades to operate the above type of alerting system will be withdrawn after 31 st December 1998. Thereafter, systems will comply with MG-4.

MG4 Specification Systems

In 1991 a new alerter system specification was introduced, produced to Home Office Specification MG-4 (Issue 2), which employs a recognised industry standard signalling system know as POCSAG (Post Office Code Standardisation Advisory Group). The transmitters operate at a maximum output of 25 Watts Effective Radiated Power (ERP). The system architecture is structured to provide each brigade with a unique coded address, together with up to 2000 separate address codes which may be allocated within the brigade to a station, a team or individual as required. (Radio Frequency Policy Statement FPS 7 refers)

All MG-4 base station transmitters must comply with the Radiocommunications Agency Specification MPT 1325 and Home Office Specification MG-4 (Issue 2). Base station aerial heights MUST NOT exceed 10 metres above ground level without the prior approval from RFCPU.

Chapter 2

Chapter 2 - Fire Control Centres

The Fire Service Act 1947 Section l(i)(c) requires Fire Authorities to secure the provision of efficient arrangements for dealing with calls for the assistance of the Fire Brigade in case of fire and for summoning members of the Brigade.

To meet this duty, fire authorities usually have a continuously staffed mobilising and communications centre, equipped with computer based Command & Control systems to deal with the receipt of emergency calls and the alerting and despatching of fire service resources within its mobilising area. Although these are considered to be the 'core' activities of a Control Centre, many additional 'non-core' duties are performed by control personnel as stipulated by the Chief Fire Officer/Fire Master.

All emergency communications for the Fire Service are channelled through the Control Centre which acts as a general communications and information resource for the Fire Brigade. It is usually housed in either a Control Suite at Brigade Headquarters or in a purpose built building within the County.

A Control Centre is staffed (in shifts to provide 24 hour cover) by uniformed professionals who, although employed under different conditions of service to Fire Fighters, are an important part of the Fire Service.

Secondary and tertiary control systems are also maintained to ensure a continuity of service. There are no national standards of efficiency for handling fire calls but many Chief Officers have set their own standards which are set out in Brigade Orders/Service Instructions or their Citizens Charter.

In most cases the Control Suite comprises a Control Centre, training room, offices, equipment rooms, kitchen/rest-room, store rooms, locker-rooms/toilets, etc. These rooms and facilities should be well designed and within easy access of the Control Centre room.

Control personnel performing duties away from the Control Centre may need to be recalled if there is a sudden spate of calls, or personnel become busy for other reasons. Easy access from anywhere within the suite will enable personnel to respond quickly.

Comprehensive guidance on the design of Control Centres was issued in DCOL 8/1997 (in Scotland as DFM 8/1997) (FRDG Publication 2/97). This is an updated version of Volume 5 of the Home Office Guidance usually referred to as 'Logica'.

The document includes advice on the Control Centre design & ergonomics, procurement and legislation.

The recommended Control Centre rank structure is:

Fire Control Operator	FCOp
Leading Fire Control Operator	LFCOp
Senior Fire Control Operator	SFCOp
Fire Control Officer	FCO
Group Fire Control Officer	GFCO
Principal Fire Control Officer	PFCO

Not all these ranks are represented in every Brigade.

2.1 Basic Call Handling Procedures

The primary function of a Control Centre is to provide the essential communication link which enables the provision of emergency firefighting, rescue and humanitarian services to the public when they call for assistance.

Figure 2.1 Fire Control Centre.
{Photo: Counts' Durham and Darlington Fire ami Rescue Service)

The basic principles of running a Control Centre have a common theme. However, the responsibilities and accountability of each rank may vary depending upon the size of the brigade.

The detailed procedures for handling an emergency call differ in each brigade according to its size and the type of communications and mobilising systems used.

Fire Control Operators are trained to elicit information from those calling for assistance. This activity requires the identification of the incident address and confirmation of the type of emergency for which assistance is required.

Difficulties in obtaining this information may result if the caller is unduly anxious or excited. A Fire Control Operator will still need to bear in mind the primary purpose is to obtain information and will need to use effective call handling skills to overcome these difficulties, possibly by calming and reassuring the caller. It may be necessary to give advice for dealing with the emergency whilst waiting for fire service attendance.

Techniques used to achieve this could include a sympathetic approach or perhaps, the adoption of an authoritative tone. The exact style being dependent upon the Operator's perception of what is appropriate in the circumstances.

It is possible that the caller may be in some personal danger. It is easy to understand that such circumstances might create a wide range of behavioural responses on the part of the caller.

Traditionally, Fire Control Operators are taught the appropriate inter-personal skills by a combination of initial training including simulation exercises and 'on the job' training by experienced personnel.

The first contact an emergency caller has with the Fire Service is with the Fire Control Operator. The way the operator handles the call is vital and to this end the operator must be immediately available to take control of the call. This will enable effective collation of call details to mobilise, and will indicate to the caller that they are being dealt with efficiently.

Further information on the training of Control Centre personnel is given in the Training Section (Appendix I).

The responsibilities of each rank within Control Centres vary from Brigade to Brigade and many of them overlap.

The following list gives **examples** of skills and responsibilities within each rank.

Control Operator (Core Skills)

- Receive emergency calls.
- Give advice to emergency callers as required.
- Identify and dispatch appropriate fire brigade resources to incidents, (if necessary receiving guidance from senior ranks).
- Be familiar with the location of fire stations and their station ground.
- Keep officers informed of incidents/occurrences as required.
- Liaise with other authorities and resources to keep them informed of incidents and request their assistance if necessary.
- Answer radio messages, relay radio messages to appliances and officers and act on information obtained.
- Deputise for Leading Fire Control Operators in their absence, subject to Brigade requirements and competence of the Operator.
- Test and inspect equipment held in control, and the secondary control, carrying out such first line maintenance as appropriate.
- Answer non-emergency switchboard calls out of office hours and direct/advise callers.
- Answer non-emergency calls from station personnel and act on information received.
- Complete incident statistics.
- Work as part of a team and react appropriately as instructed and directed by officers.
- Ensure that levels of personal conduct are maintained in accordance with the standards prescribed in the Fire Service (Discipline) Regulations 1985 and by accepted Service Procedures.
- Ensure compliance with current Health and Safety Legislation, including Display Screen Regulations 1992.
- Comply with the Brigade's Equal Opportunities Policy and other relevant legislation at all times.
- Undertake control/watch administration duties as required.

Leading Fire Control Operator

- Duties mirror those of a Fire Control Operator with the addition of supervisory duties.
- Assist and support other officers and be responsible to the Watch Officer in respect of the day-to-day, management of the Control centre and development of personnel.
- Deputise for a Senior Fire Control Operator in their absence.
- Assume duties as Watch Officer in the absence of a Senior Fire Control Operator and/or Fire Control Officer, subject to Brigade requirements and suitability of the Leading Fire Control Operator.
- Participate in the design, programming, running and monitoring of training programmes.
- Provide support and guidance to probationary Fire Control Operators and personnel preparing for examinations.
- Be familiar with the general command principles necessary to undertake the variety of other such tasks and duties as may be required, to meet the needs of the Brigade.

Senior Fire Control Operator

The tasks listed below may be the responsibility of a L/FCOp in Brigades that have S/FCOp's as Watch Officers.

In addition to the L/FCOp duties:

- Take charge of Command and Control activities during the absence of the Watch Officer.

- Assist and support the Watch Officer in respect of the day-to-day management and development of personnel.

- Ensure that all resources have been dispatched correctly.

- Prepare and carry out watch training programme, and maintain training records as required by the Fire Control Officer.

- Undertake administrative/project work as required and assist in the supervision and completion of Control/Watch administrative workloads.

Fire Control Officer

In addition to the above:

- Monitor emergency calls and take command of the dispatch of all resources.

- Ensure that fire cover is maintained throughout Brigade area, utilising resources from neighbouring Fire Brigades if necessary.

- Ensure compliance with all Brigade Instructions, policies and guidelines.

- Identify training needs and manage the design, programming, running and monitoring of training.

- Management of Control/Watch administration duties including financial responsibilities as required.

- Assist and support other officers and be responsible to the Group Fire Control Officer (if applicable) in respect of the day to day management and development of personnel.

  This may include conditions of service, sickness monitoring and welfare issues.

- Assist and support management in the development and planning of mobilising strategy.

Group Fire Control Officer

In some cases an FCO or GFCO may also hold other references within the Brigade. These may include Personnel Officer, Communications Officer or, for example, in larger brigades the Watch Officers may hold the rank of GFCO.

The tasks listed below may be the responsibility of an FCO in a brigade which does not employ a GFCO:

- Responsible for the overall management of the Control Centre, its personnel, equipment and all other resources to ensure the effective, economic and efficient operation of the Control Centre, in line with Brigade policies and procedures.

- Attend control during a major incident or spate conditions, and take strategic command and provide support as appropriate.

- Keep Control personnel informed of Brigade policies, procedures and standards.

- Monitor the welfare and motivation of personnel whilst constantly seeking to promote and improve teamwork and efficiency.

- Establish an effective working relationship with Control personnel.

- Monitor all Control Centre personnel in respect of performance, conditions of service and training where appropriate.

- Development and planning of mobilising procedures.

- Development and planning of control/station communication systems.

- Maintain an efficient and effective Command and Control centre within allocated budgets provided.

Principal Fire Control Officer

The Principal Fire Control Officer rank is usually used in the larger metropolitan brigades and generally performs the same role as FCO/GFCO in managing the Control Centre. Other brigades may introduce the rank to lead special projects or be head of section for the Centre i.e., Command/Control/Communications and IT, or perhaps perform the management function of a DO with responsibilities for Personnel & Development, Equal Opportunities or Health &

However, in some Brigades the PFCO may be responsible for developing brigade mobilising policy as part of the Principal Management Team.

2.2 Control Centre Staffing Levels

Her Majesty's Fire Service Inspectorate (and the Scottish Office Fire Service Inspectorate) is charged with the duty of obtaining information on how fire authorities are performing their functions, with particular regard to efficiency and effectiveness. Included in these functions are the brigade Control Centre and the manner in which it is staffed and operates.

To assist HM Inspectors and brigades in setting staffing levels within the Control Centre, a Staffing Model has been developed. This model was issued to brigades as **DCOL 6/1996 (in Scotland as DFM 6/1996).**

The model is designed to give an **indicator** of the number of operators required to handle and process a given workload to a given *Grade of Service*. The model is not intended to take into account levels of supervision, sickness, training or control personnel required for projects, etc. It is used as a means of determining the number of operators required, from which decisions regarding establishment and officer levels can be made.

HM Inspectors will also use the model to assess the adequacy of brigade staffing requirements.

Brigade managers are, of course, free to run the staffing model within their own brigades. However, the Home Office recommends liaison with HM Fire Service Inspectorate to ensure correct interpretation and to develop a common approach.

HM Fire Service Inspectorate does not currently recommend a Grade of Service but may do so in the future.

Additionally, Fire Service Circular October 1975 recommends rank levels for control personnel established by reference to the population within the Brigade area.

Chapter 3 - A brief history of the 'Fire Control Centre'

In 1997 the Fire Service as we know it was 50 years old, over those years a new career has evolved; that of Fire Control Operator.

In the very early days strategic mobilising to fires was virtually non-existent. During the 1800s, numerous fire insurance companies formed their won brigades of 'watermen'. Following a call to 'fire', sometimes several of these Insurance Brigades would send their 'engines' and, on arrival, would look for the 'fire mark' to establish whether the victim was insured and by which company. In the free for all that ensued, the brigades could find themselves working against each other instead of working for the common good, to the detriment of the public. There was little co-ordination of resources or direction of the overall situation.

Over the next century and a half that was to change significantly.

One prime innovation which would start the long haul to a unified well organised service, was the Metropolitan Fire Brigades Act, 1865. The act covered the City of London and *'all other Parishes and Places for the Time being within the Jurisdiction of the Metropolitan Board of Works'*. The Act also stated the need *'for the establishment of Telegraphic Communication between the several Stations in which their Fire Engines or Firemen are placed, and between any such Stations and other parts of the Metropolis'*.

This enabled the receiving and transmitting of locations of fires to all stations connected by the telegraph system. It was the first indication of mobilising from a source remote from the location of the fire and, by necessity, carried out by a fireman at the fire station receiving what was called a 'running call'. A situation that exists to the present day.

Metropolitan Brigades had an advantage over the smaller rural Brigades by nature of their size and the population they served. They were far better equipped financially to exploit the new technology that appeared, such as a street fire alarms and fire detectors in commercial premises.

In rural areas, private telephones were scarce and public telephones were not as plentiful or well situated as they are today, and there were no street fire alarms. The firemen in rural brigades were usually part timers who would rely on being called by a 'knocker up' or by the sirens that were installed during the First World War. These sirens were still in use well into the 1970s.

With war approaching, the government mounted a recruitment campaign to encourage men and women to join the Auxiliary Fire Service (AFS). Women were encouraged to join as drivers, or to work in fire stations doing office work or watchroom duties. Some women opted for motorcycle training and driving lessons, while the majority learned watchroom procedures and the vital process of mobilising appliances. They all had basic firefighting training. (The AFS became the National Fire Service approximately one year after the war started. It was reformed in 1947 to run until the mid sixties.)

One of the difficulties of forming a large number of small brigades into a National Fire Service was that most of the equipment, hose couplings, pump deliveries and appliances, etc., were all different. This caused obvious problems when one brigade was called to assist another. There was a desperate need for standardisation.

All emergency calls were received at the local General Post Office (GPO) Telephone exchange, (at this time telephone exchanges only covered a

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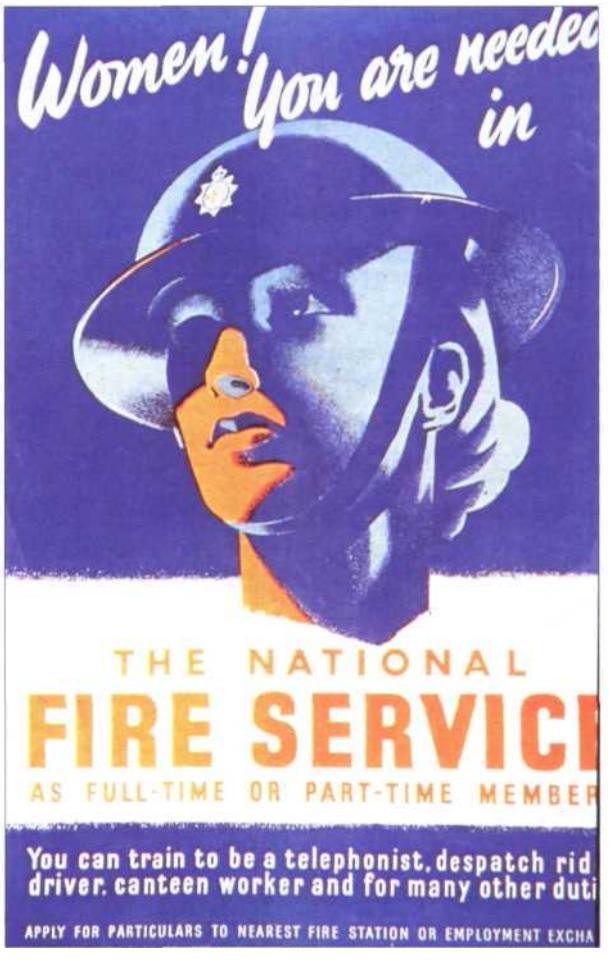
Women! You are needed in
THE NATIONAL
FIRE SERVICE
AS FULL-TIME OR PART-TIME MEMBER
You can train to be a telephonist, despatch rid
driver, canteen worker and for many other duti
APPLY FOR PARTICULARS TO NEAREST FIRE STATION OR EMPLOYMENT EXCHA

Figures 3.1 and 3.2 Posters used during a recruiting campaign in World War II.

small area and there were a great number of them), and passed to the Wholetime fire station in that area where a 'Watchroom' was continuously manned, either by a firemen, firewomen or a combination of both.

After the Second World War, communication was still a laborious and lengthy process. Watchrooms or Control Rooms in various brigades evolved differently, some were staffed by firemen who had a rota for 'Watchroom' duties while others were staffed by firewomen who had served in the National Fire Service. Many of these women stayed on after the war to become the forerunners of today's control operators.

In 1947 the Fire Services Act was passed to make further provision for fire services in Great Britain *'to transfer fire-fighting functions from the National Fire Service to fire brigades maintained by the councils of counties'*. With brigades under the auspices of the County Councils the long process of standardisation of all equipment continued. This included the amalgamation of some fire station watchrooms into divisional control rooms which, because County Councils were also responsible for the ambulance service, were sometimes shared with ambulance personnel.

Unfortunately, whilst World War Two had produced some well managed and equipped fire control rooms up and down the country under the NFS, these were thought to be too elaborate for county brigades, and were dispensed with.

Mobilising was still carried out by the duty watchroom attendant who would take call details, dispatch the first attendance and, if necessary,

Figure 3.3 London Fire Brigade Control Room, 1937.
(Photo:LondonFireBrigade)

Figure 3.4 London Fire Brigade Wireless Control Room at HQ.
(Photo: London Fire Brigade)

Figure 3.5 AFS Fire Women in Watch Room.
(Photo: Kent Fire Brigade)

Figure 3.6 GPO Telephone Exchange, late 1960s. Note red lightbulb for 999 calls.
(Photo: Hertfordshire Fire and Rescue Service)

Figure 3.7 Kent Fire Brigade Control Room, I960.
(Photo: Kent Fire Brigade)

Figure3.8 Control Room using VF System 'A', 1980.
(Photo: Kent Fire Brigade)

pass the call to a divisional or district control. It was the duty of the watchroom attendant to record all fire calls, as well as officer and appliance movements, in the 'log book'. In fact everything was meticulously recorded, usually in beautiful handwriting.

In some cases, Kent for instance. Brigade controls were responsible for plotting, logging of all calls with associated paper work, fire reports, accident reports and statistics, but not at any time talking to the originator of the call.

Improvements in the telephone network had revolutionised brigades. The introduction of a radio network was the next step towards improving brigade-wide communications.

The radio scheme was sometimes shared with the Police (provided fire control asked 'nicely' and the police were not too busy, the scheme would be opened to allow for transmission) or, sometimes, the scheme was shared with another brigade. Police and Fire Brigade radio schemes were the responsibility of the Home Office Communications Branch, later the Directorate of Telecommunications, and remained so for many years.

These early systems, although now construed as relatively primitive, were to further enhance the capabilities of the service. Once each Fire Brigade had their own private mobile radio networks it became more practical to operate the radio from one location. It was one more step towards a single control.

Contact with fire stations was made by land line and 'part timers' or retained firemen were called in by housebells or sirens, alerters for retained firefighters were not introduced until 1968.

Control rooms were now capable of reliable contact with stations by means of the 'K system' and subsequently, among others, the VF 'system A' and private wires, all of which used land lines. These mobilising systems were very reliable but rather slow, the method used to communicate with the station or stations required was the human voice, and all turn-out instructions, with additional information if necessary, were repeated. Mobilising was accomplished by checking the pre-determined attendance (PDA) card for the parish or street to determine which appliance/s to send before alerting the station/s. These cards were kept in large 'bins' in the control room and if the brigade used street mobilising there were many hundreds of cards.

Operators prided themselves on their topographical knowledge and remembering the attendance for many areas or special risks, only using the PDA cards for confirmation. Fire calls were recorded by hand on individual incident forms and, in some cases, the old 'log book' was still running!

At this time, nationally, control staff personnel were a mishmash of backgrounds and experience. Control was thought to be the easy option and many operators were firemen who were on the run down to retirement, or sick and on light duties. Some brigades started to employ women because they couldn't get men to work shift work for the low rate of pay. Others, of course, had long established specialised personnel.

The developing use of computers generally in the 1970's inevitably led to thoughts of computerised mobilising. To have finger tip control of all brigade resources, PDA's, call logging, statistics and instant recall of information seemed very exciting. There was talk of 'paperless' control rooms! In fact because of this belief many of the consoles designed at that time had no 'working' space. This mistake was rectified next time around.

In 1972 two new courses were introduced at the Fire Service College, one was for Communications Officers, a post usually occupied by an operational fire officer, and the other was the very first course especially for Control Room staff, a Supervisory Officer's course. By 1974, in part due to Local Government reorganisation, the concept of a central control room for each County was well established. This was also the year in which Local Area Health Authorities were formed and Fire Brigades and the Ambulance Service went their separate ways.

1975 saw the standardisation of Control staff rank structure and markings, and recruiting was geared to the special skills required of an operator.

Grampian Fire Brigade was the first to use computer aided dispatch, closely followed by Greater Manchester Fire Brigade who went live with a fully computerised Ferranti Argos system in 1979. By the late 1980's almost all of the Fire Brigades in the United Kingdom had a computerised mobilising system although some were more sophisticated than others.

The number of emergency calls is increasing year by year, as is the type of emergency. To reflect the diverse nature of fires and special services they now attended, many Fire Brigades have changed their title to 'Fire and Rescue Service'.

The Home Office Guide to Fire Brigade Mobilising Systems, known as the 'Logica' report, was published in 1990 to help Brigades with the specification, procurement and support of their second generation mobilising and communication systems.

Long gone are the days when all that was required of the watchroom attendant was to wind a handle for the station to turn out to a fire and hope that contact was made. The requirements and expectations of the control room has changed, and the improvements in communications have enabled a faster and more effective response.

Nowadays local knowledge is not enough, even the most experienced Control Centre Operator could not retain the large quantities information required by a modern Fire Service. All incidents and relevant information are logged and stored on the database of modern computerised mobilising systems.

An operator now requires keyboard skills and a knowledge of computers: retrieval and statistical systems: chemical and hazardous material, Management Information Systems (MIS): mapping systems and most importantly, call handling techniques.

An operator also needs to have a basic understanding of the many communication systems, be they voice or data, that are used in the fire service. In fact it is becoming increasingly difficult to distinguish between Communications, Mobilising and IT systems.

The Control Centre as the name implies is, by its very nature, an essential part of any Fire and Rescue Service. Instead of the free for all of the early days, firefighters can rely on being well informed about the incident they are attending, being kept up to date with all developments as they occur, and have the knowledge that requests for help or assistance will be quickly and efficiently acted upon.

The skill of the operational firefighter together with the professionalism of their colleagues in the Control Centre, combine to provide an efficient and effective service to the public.

Chapter 4

Chapter 4 - The 999/112 emergency service

4.1 BT

The Public Telecommunications Operators (PTOs) are obliged, under the terms of their licences, to provide a public emergency call service by means of which any member of the public may, without charge, communicate as quickly as practicable with any of the appropriate local emergency authorities (EAs) to notify them of an emergency.

The 999 call service provides national coverage in respect of the four main emergency services, i.e., police, ambulance, fire and coastguards. Other services can also receive emergency calls via the police. These organisations are cave rescue, colliery rescue, mountain rescue, air/sea rescue, diver emergency and cardiac units.

BT takes approximately 21 million calls each year, including 2 million mobile 999's and calls from cable networks. Cable & Wireless (formerly Mercury) take 2.8 million including mobile and cable company calls, whilst Kingston Communication handles 200,000 calls. Requests for police help account for some 55 per cent of emergency calls, while the ambulance service accounts for 33 per cent and the fire brigades for the majority of the remaining 12 per cent. Some 50 per cent of all 999 calls are false calls, where callers make no request for an EA, and are safely filtered by BT and Cable & Wireless operators at the request of the EAs using agreed procedures.

4.1.1 The British Telecom fixed telephone system

There are fifteen BT Operator Assistance Centres (OAC), these are at Aldershot, Aylesbury, Bangor, Belfast, Blackburn, Bristol, Cambridge, Glasgow, Hastings, Inverness, Leicester, Newcastle, Newport, Thanet and Warrington.

Figure 4.1 A BT Operator Assistance Centre. [Photo:BT)

The trunk reservation facility will be used to ensure that there will always be at least two circuits reserved for 999/112 calls on a route from a digital local exchange. More importantly, however, this facility allows an additional circuit to be reserved for a 999/112 call each time an existing circuit is taken into use for a 999/112 call. All of the circuits in a route are thus, potentially, available for emergency use. This gives protection in disaster situations which cause a sudden surge of 999/112 calls.

If it is not possible to route operator traffic to the primary operator centre due to congestion or failure within the network or evacuation of an Operator Assistance Centre, 999/112 traffic will be routed to an alternative OAC.

The connection of an emergency call involves four main phases:

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(1) Connection of the caller to the operator via the 999/112 code;

(2) Selection by the operator of the required Emergency Authority Control Centre (EACC);

(3) Onward connection of the caller to the EACC; and

(4) Confirmation that the connection has been established with the appropriate EACC and ability to provide further assistance to the caller or EA when required.

The operator will monitor the call until the caller has passed their location and is clearly giving details of the incident. The operator normally holds the call in the system without listening (unless there are difficulties) until both the caller and EA have cleared the line.

It is the responsibility of the EA Control Centre staff to obtain adequate address information from the caller to enable the EACC to locate the incident being reported.

4.1.2 Operator call-handling procedures

The action of dialling 999/112 on BT's public telephone network in the UK automatically routes the caller through to a designated Operator Centre. Here, if it is not immediately answered, the call is visually and audibly signalled on all operating positions and, in addition, a special red light operates to ensure that the call is given immediate attention by a BT operator.

To cater for unforeseen circumstances EAs have to provide three separate routes from the Operator Services Centres to the emergency service. The secondary and alternative routes would normally be used in sequence in the event of an unusually high level of traffic or a fault on the primary route.

BT will allow a 30 second delay with no reply before another route is attempted unless the EA control centre has a call queuing system, in which case additional time is allowed. For this reason it is vital to inform BT if any call queuing system is installed.

These routes are:

Primary

This is the route that the PTO operator will initially use to connect a caller to the EACC and the EA must provide sufficient capacity on this route to handle normal 999/112 traffic-distribution.

EAs will reserve primary routes exclusively for receiving 999/112 calls.

Secondary

In circumstances where the PTO operator receives no replyon the primary number after 30 seconds, the operator will connect the call to a secondary number provided by the EA, except where call queuing is used. This procedure should only be necessary in instances when the EACC has an unusually high level of traffic or a fault in its switchboard or one of the PTOs' networks.

Alternative

In the event of a major problem which results in the primary and secondary routes to an EACC being unavailable to the PTOs, the EA should provide the PTOs with an alternative means of taking delivery of the call, ideally at a different EACC for maximum security.

To provide adequate security, this alternative number must be served by a different network route from that providing the primary and secondary routes. EAs would have to consider, where appropriate, which EA Control Centres are used as alternatives to each other.

These routes are agreed between the EA and the BT Emergencies Services Manager. Changes arranged by EAs have to be notified directly to the ESM giving at least two weeks notice.

All the routes have to be staffed on a 24 hour basis.

When a PTO operator answers an emergency call that has originated from a digital exchange, the full national calling line identity number (CLI) will be automatically displayed on the operator's VDU.

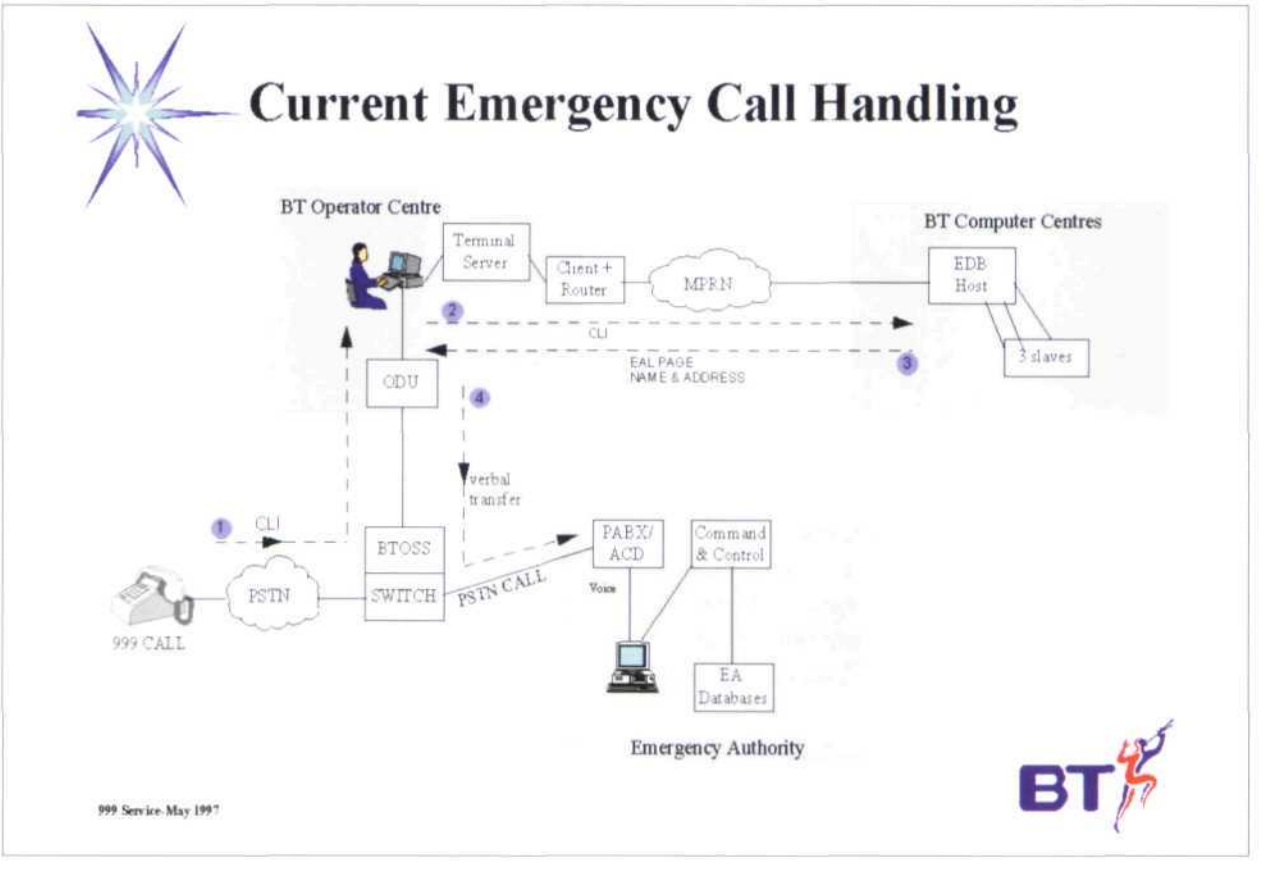

Figure 4.2 BT emergency call handling system.
(Diagram: BT)

This removes the necessity for an engineering trace to identify the calling line if the caller is unable to provide this information.

The CLI number uses a different mechanism to BT's Caller Display and Call Return (1471) service. The number cannot be altered or withheld by the caller.

Prior to all the PTOs completing their digital networks, calls originating from an analogue exchange will not show the full telephone number, though a partial display of the exchange code may sometimes be obtained. The customer may therefore still need to be asked for their number in order to route the call correctly.

The originating calling information (CLI) will be used to automatically display details of the appropriate EACC connect-to numbers.

It is worth noting that an increasing number of business customers have DDI systems and/or private networks. In these cases, the number automatically presented to the PTO operator is usually the outgoing number of the main switchboard. This will be the number passed to the EA and may be different to the number the caller may give if asked by either the PTO or EA operator.

There are also some private networks that extend over several areas. Their 999/1 12 calls could be fed into the PTO networks in only one of these areas. This will lead to inevitable problems as they will be presented with a telephone number applicable to this area and, therefore, routed accordingly. These will only become apparent at the EACC when the caller is questioned as to their location.

The operator establishes which Emergency Authority is required by answering the call with '**Emergency, which service?**'

If the caller needs to be asked for their number this is entered onto the screen.

The operator hands the call over by passing the Operator Assistance Centre (OAC) name and the caller's number and listens while the caller passes their location. If this has been given clearly and the call is progressing, the call will be held in the operator's system (without listening) until the call is complete. Operators normally listen throughout in difficult cases, for example, panicking callers or where there is a language problem.

If it is necessary to speak to the BT operator again it should be possible to call them back onto the line while the call is being listened to. At this stage of the call there are two options to speak to the BT operator.

(1) Operators can normally see when the caller and the EACC have cleared. If the EACC has the necessary facilities it is possible for EA operators to cause the word 'Flash' to appear on the BT screen.

(2) The operator may be alerted by failure to clear the line, although this may take some time if the operator is dealing with another call.

If details of the call are required once the call has been released, it will be necessary to dial the Operator Assistance Centre number allocated to each Brigade. **The allocated number should be used even if the call** was **passed via** a **different OAC**.

Every emergency call is recorded both on magnetic tape and on a call printout which shows basic call details, such as time, telephone number and address of the call. BT's recording of emergency calls is from the time that the call is answered by the BT operator to the time when the call to the EA is cleared by the caller and the EA, the speech of all parties is recorded. All 999/112 call records are held for three months.

4.1.3 Mismatches between EA and Fixed Network Operator Boundaries

BT has over 7500 exchanges, each with its own code, it is these codes that determine how the call is routed. BT exchanges have grown up over the last 90 years as the cable network has evolved and each has a defined catchment area averaging 4km in radius.

Exchange area boundaries do not always coincide with EA boundaries. Where 'mismatches' exist, careful planning and general agreement between neighbouring Chief Fire Officers/Fire Masters and the BT Emergency Services manager has to be reached on which EA Control Centre will take the calls from the whole of the split exchange area in question.

The Fixed Network Operators will connect all directly connected customers to the appropriate EACC for the agreed geographical areas wherever possible. It will be the EA's responsibility to pass information if necessary to another EACC in these mismatches cases.

4.1.4 Provision of ex-directory information

BT operators will only provide name and address information for numbers from which a recent 999/112 call has been made. All other routine requests for such information must be made by EAs through BT's Network Special Investigations Group.

In providing an XD/NC service BT undertakes not to give the number to anyone outside BT including EAs. BT has laid down procedures to enable urgent calls to be connected to XD/NC customers without revealing the number. EAs requiring such a connection must contact BT OACs using 100 service where the operator will ask a number of questions to support the request before connecting.

4.1.5 Access to tape recordings of Emergency Calls

BT will record all calls terminating on 999/112 circuits. Calls are recorded from the time the call is answered by a BT operator until the EA and caller clear the line, and the circuit is released.

Requests from EAs to listen to, to make notes about, or be given a copy of a recording of a 999/112 call must be referred to the BT Network Special Investigations Group.

These requests must be authorised by the agreed level according to the Code of Practice which states:

Access to emergency call records can be obtained in two forms:

Normal For investigatory purposes where it is required as evidence or similar use. Arrangements for access will be agreed at the time of request.

Urgent Where instant access is required to respond to a 999 incident. (Current equipment means this would take several minutes.)

The authority levels for access required are:

Normal Duty Principal Officer

Urgent Senior Duty Control Room Officer

An authorised representative of the EA (not necessarily the Authorising Officer) must be present when the tapes are being played at an Operator Services Centre.

BT will only keep original 999/112 recording tapes for a period of 3 months. Evidential quality copies can be requested if necessary.

BT will apply to the Chief Officer of the relevant EA for similar recordings of calls made by the EAs.

PTO's inform all their customers to use the 999/112 code when making emergency calls. PTO's do not tape record emergency calls made on any other circuit. However, such calls are processed despite the use of the incorrect code.

4.1.6 Calling Line Identity (CLI)

Since 1985 BT have been modernising their network and converting from analogue to digital exchanges. This modernisation is almost complete giving 99% CLI coverage, which means BT operators have instant access to the callers address on 40 million lines.

Once BT developed CLI for their own operators, the emergency services requested an enhancement to 999 services to reduce call handling times and the number of hoax calls. Their requirement was an enhancement which would allow the telephone number and address of the caller to be automatically displayed on the EAs own mobilising computer screen.

The advantages of CLI are:

- Caller's number and address automatically available on answer, no need for information to be passed verbally or the EA operator to type. Reduces typing errors.
- Name of BT OAC displayed, for call back if necessary.
- Caller can speak to the EA sooner, reducing frustration or panic. Address and telephone number is simply confirmed.
- CLI overcomes the problem of spelling, pronunciation and language difficulties.
- Early indication of hoax calls - the auto-address will reveal if the caller is giving a false address or at a payphone often used to make malicious calls, or perhaps a mental hospital.
- As mobile zones decrease in size the automatic Zone Code may help EAs to question callers who are unsure of their location.

BT have devised a system which requires an ISDN link from that operator centre which is used to forward CLI to the EACC. On receipt of a call the EAs mobilising system will dial into the BT database for address information which will be displayed on the EA mobilising screen, this will take less than 10 seconds, (a pilot trial in place at this time is providing the information in one second). This is technically a dial-up system (which will have a small cost implication for the EA) but will appear automatically to the EA operator.

Trials of this system have commenced in the Ambulance service and will shortly commence for the Police. The Fire Service (CACFOA) have decided to wait for the long term strategic solution, when, once European Standards have been developed, should allow CLI name/address to be passed together.

The trials assess:

- The performance of the technical solution.
- Processes such as audit trails.
- The most cost effective packages for rollout.
- Savings in time to despatch (EA).
- Reduction in call handling times (BT and EA).

The results of these trials will give BT information which will be used for the long term solution when the European standard is agreed.

Whichever system is used, it will only be possible to automatically obtain the telephone number and address of the caller if they have dialled 999 or 112. The system design dictates that these calls follow a certain technological route which safeguards the integrity of the BT system.

It will not be possible for any EA to type in a number and interrogate the BT database. By the act of dialling 999/112 it is deemed a caller has given consent for this information to be used and, therefore, complies with the Data Protection laws.

Although in most cases the emergency call is made from the address of the fire, it should not be assumed that this is so. Experienced EA operators will recognise the dangers and know how easy it is to get an affirmative answer to any question.

Training on call handling procedures will have to reflect this.

4.1.7 Network Resilience

In the event of a major failure to a part of a PTO's network, the PTO will notify the affected EAs as soon as possible after the failure is identified, or is anticipated.

The process for informing EA's of any BT exchange that fails to give customers 999 access commences when a regional Network Operations Unit (NOU) detects a failure that causes loss of 999 access. Once the extent of the problem is known a report of the failure is faxed to each appropriate EA Control Centre (Police, Fire, Ambulance and Coastguard). In addition the Network Operations Unit draws attention to the fax by telephoning the Police control, which in turn telephones the other affected EAs. If necessary, progress reports are faxed at periodic intervals and finally a fault clearance report is sent once 999 access has been restored. The process includes the provision by BT to the EAs of maps showing the area covered by each of its exchanges.

EAs and relevant PTOs should prepare local contingency arrangements to cover the receipt of emergency calls during conditions of serious breakdown in the PTO network.

4.1.8 Priority Fault Repair Service

The conditions in the PTO's licence requires them to provide a free Priority Fault Repair Service to those emergency authorities who receive 999/112 calls on lines connected to the PTO's network. When notified of any fault or failure which causes interruption, suspension or restriction of the telecommunication services provided by the PTO, the PTO will restore those services as swiftly as practicable and with a priority, so far as is reasonably practical, over Fault Repair Services to other persons.

Where an EACC has connection directly to a PTO for an Emergency Call Service, Priority Fault Repair Service will be extended to all 999/112 circuits in accordance with the relevant condition of the PTO's licence. This is Condition 9 of the Cable & Wireless licence and Condition 10 of the BT licence.

The BT Priority Fault Repair Service will apply where BT and Cable & Wireless use common terminations supplied by BT.

4.1.9 BT National Emergency Linkline

The National Emergency Linkline is a service designed to give nominated customers a quick and easy means of contacting BT to request assistance during emergency situations.

Nominated customers are primarily the Emergency Services and Local Government, as they would normally be responsible for co-ordinating

emergency incidents. However, the service can be made available to Health Authorities, the Armed Forces and those public utilities that are likely to play a significant role in major emergencies.

This service has been specifically set up for use in the event of Civil Emergencies and major disasters. It is NOT for normal business enquiries.

BT's modern digital technology uses a flexible call routing tool known as Advanced Linkline Services. This facility can direct calls from a special national telephone number to one or more pre-selected answering points. The National Emergency Linkline number dialled from anywhere in the UK, connects the caller to the nearest Emergency Linkline reception point, normally the local BT Network Operations Unit. The NOU will ensure that a request for assistance is handled promptly and that all necessary parts of BT are alerted.

The service is available 24 hours a day.

When requesting assistance a caller must identify themself and the organisation that they represent and provide a telephone number on which they, or another representative, can be contacted. They should give as much detail about the incident as possible to enable BT to react quickly.

The information should include:

- Accurate location (e.g. address/grid reference).
- Casualty situation (e.g. is an enquiry bureau being set up?).
- Access problems (e.g. difficult terrain or parking restrictions).
- On-site security (e.g. will BT identity cards suffice?).
- Reporting instructions (e.g. who should BT people report to?).
- Communication needs (e.g. requirements at the scene/incident control?).
- Safety issues (e.g. are there any hazardous conditions to consider?).

The National Emergency Linkline number must not be disclosed outside the organisation. This will ensure the service is not abused by unauthorised users.

To get more information (including the National Emergency Linkline number) contact the local BT Zone Emergency Manager.

4.1.10 (Government Telephone Preference Scheme

The Government Telephone Preference Scheme (GTPS) provides a contingency facility for the withdrawal of **outgoing** telephone services from the majority of customers on a telephone exchange. The scheme is designed for use in a serious crisis when increased use of the telephone network is causing severe congestion and preventing the emergency services and other essential users from making and receiving calls. At present the scheme only applies to BT and Cable and Wireless.

Lines that have their outgoing service withdrawn under the scheme will retain the capability of receiving incoming calls. Normal service will be restored to all customers as soon as possible.

Rules for the selection of lines for inclusion in the scheme have been set by Government. These rules and other information about the scheme are contained in a Government Notice.

The GTPS can only be invoked by the government in exceptional circumstances. However, the facilities it provides can be used by BT or Cable and Wireless as part of their network management arrangements if their network is heavily overloaded or damaged.

The scheme only operates over PSTN lines. There is no charge for this service.

All exchange connections are placed in three categories.

Category 1 consists of those lines essential to Government and the emergency authorities in a severe crisis or emergency which is affecting the public telephone network.

Category 2 includes lines additional to Category 1 that are required to maintain the life of a community during civil emergency.

Category 3 covers the remaining lines not entitled to special preference during an emergency.

All Government departments have a designated authority to nominate for inclusion in Categories 1 and 2, this process is known as 'sponsoring'. **Sponsors are required to notify BT or Cable and Wireless annually of the lines they wish to nominate for inclusion in (JTPS.** The GTPS administration is handled by BT and Cable and Wireless Emergency Planning Managers.

4.1.11 Secondary Control

As well as providing PTO's with secondary and alternative numbers, Fire Brigades should have alternative arrangements to cover the receipt of emergency fire calls during conditions of serious breakdown, either in BT's network or their own brigade communications systems.

These arrangements usually involve a 'secondary control' set up either in a different building on the same site or at a different location. Consideration also has to be given to the receipt of calls during the interim period, EAs should make use of automatic call diversion facilities where possible.

Managers of Control Centres which normally receive emergency fire calls should run exercises periodically to ensure that all staff are familiar with the contingency arrangements.

4.1.12 Publicity/ Public Education

The Public Telecommunications Operators and the Emergency Services continue to be actively involved in various education programmes aimed at young school children.

Apart from the Strategic Framework for Combating Malicious Hoax 999 Calls **(DCOL9/96),** many separate initiatives have been taken by the PTO's, Police, Fire and Ambulance services to educate the public as well as reduce the number of hoax calls.

It is interesting to note that the Coastguard receive very few malicious or hoax calls.

Education and advice to the public is ongoing, and will become more important if the Police and Ambulance services introduce 'second priority' numbers for minor emergencies.

HM Fire Service Inspectorate and CACFOA advise against Fire Services using a 'minor emergency' number.

It is not generally recommended that persons should call the fire brigade by dialling the fire station or the fire control number direct, and the reasons for this are as follows:

- Directly dialled calls cannot be monitored by the BT operator.
- It is seldom possible to trace the origin of a directly dialled call.
- The call would be delayed if the fire brigade number were found to be engaged or out of order.
- Payphone users would need to insert coins which, in an emergency, might not be readily available.

Entries in telephone books

A standard page is included in the preface of all telephone books on the use of the 999/112 emergency service. Administrative telephone numbers of fire brigade headquarters and other departments or establishments should be inserted in telephone books under the heading of the local authority concerned.

4.2 Cable & Wireless 999 service

(Formerly Mercury Communications)

Cable & Wireless work within the Code of Practice for The Public Emergency Call Service between Fixed Network Operators and the Emergency Services.

In February 1997 Cable & Wireless outsourced the management of their Operator Services to a company called EXCELL Multimedia Services Ltd. As

well as handling all 999 calls, Operator services handle Operator 100 and International Operator Services. Any query or problem with the 999 service should be referred to Cable & Wireless.

Cable & Wireless handle approximately 2.8 million 999 calls each year. It provides service to its directly connected customers and to the customers of a number of Other Licensed Operators including (but not exclusively) cable carriers and mobile networks. The Emergency Service operators are located in two call centres in Birmingham and one in Glasgow which handle all 999 and 112 traffic originating or connecting onto the Cable & Wireless network anywhere in the UK.

These call centres are fully resilient being on separate power supply lines with separate multiple connections to the Cable & Wireless trunk network. The sites have on-site emergency power generator provision. They share the same management and ancillary structure.

999 and 112 calls entering or originating on the Cable & Wireless network are routed by the shortest possible route to one of five dedicated switches for Operator Services traffic, located around the country. These switches form a complete resilient, fully networked five-node system for routing traffic to the Operators. The system has full 24 hour support and queues have Real Time Management Information Systems to ensure all calls are answered immediately. The system is configured to give these calls priority over all other traffic on the Cable & Wireless network.

The emergency operators in the Birmingham call centres connect callers to the Emergency Service. For reasons of cost and speed the call will route over the Cable & Wireless network emerging, if necessary, onto the BT network at the nearest Point Of Interconnect to the Emergency Authority. At no time are BT 999 operators involved in Cable & Wireless 999 procedures, only BT's local network where required by the Emergency Services own telephone network.

4.2.1 Operator call-handling procedure

When a directly connected, One2One or Cable customer dials 999/112, an Emergency call attempt will be recorded within the call centre by means of an audible and visual signal. The call is immediately given the highest priority. The operator holds any existing call on the console and answers the emergency call "Emergency, which service please?".

Simultaneously, the operator will have received a display of the 'calling line identity' - originating callers telephone number, in addition to which, automatic voice recording is activated. If the call has originated from a cellular caller a 5 digit area zone code will also be presented.

At this time, the operator will initiate a search of the customer records database (Front Office Directory (FRNT)), using the displayed calling line identity and/or zone code. If the search is completed successfully, the operator will have the following customer details displayed:

- Caller's telephone number.
- Name.
- Address.
- Primary connect - to numbers of each Emergency Service.
- Secondary connect - to numbers of each Emergency Service.

(Where zone code is used, callers name and telephone number will not be available.)

Where callers details cannot be retrieved from FRNT, then the operator will refer to a 'backup' screen on FRNT which will provide the relevant connect-to numbers in accordance with the callers STD code presented in the calling line identity or cellular callers given county location.

If the caller is dialling from a company site, the operator will ask the caller to confirm their telephone number. By doing this the operator will have access to a direct dial extension line within the site. The calling line identity will often only display as a main switchboard number of the site.

The operator will advise the caller that they are being connected to the requested Emergency

Service. Once connected and an answer from the Emergency Service is gained, the Operator will introduce the caller by announcing:

- Operator call centre identification;
- Customer's calling line identity; or
- Direct line number, provided by business caller.

Once these details are given, the Operator will hold the call on the console, and leave the call in progress, allowing the Operator to become available to answer other incoming 999/112 calls. The Operator will only remain on line if requested to do so by the Emergency Service.

Once the operator has left a conversation in progress between the Emergency Service and the caller, the console will visually display the call status. When the call is complete, and all parties have cleared the call, the Operator can relinquish the call. At this point, a call print out will be generated, providing the following details of the call:

- Date.
- Relinquish time.
- Operator distribution cabinet number.
- Console number.
- Operator identity number.
- Call type (999/112).
- Calling line identity (& zone code where applicable).
- Number that the call was extended to.
- Any operator comments relating to call.

ified police control relevant to the area and advise of the caller's attempt and any other useful information e.g., name, address, telephone number.

If during any 999/112 call attempt where caller's details cannot be retrieved from FRNT, then the Operator will contact the Switch Network 'B' division (SNB) to obtain detailed information.

Where the caller is a subscriber of another Licensed Operator, dedicated 'hotline' numbers have been set-up to each operator in order to provide speedy retrieval of information.

Cable & Wireless have no plans at present to automatically forward CLI information to Brigade mobilising systems.

4.2.2 Enquiries and requests from Emergency Services

In some instances, an Emergency Service may find it necessary to request additional information or to seek clarification after a call has been released by the Operator. The Emergency Service must call the designated numbers within the centres and advise what additional information is required. The request will be actioned by a Team Leader or Operator immediately.

Access to emergency call records and recordings should be obtained in accordance with the Fixed Network Code of Practice.

4.3 Kingston Communications

Kingston Communications Ltd are little known outside the Hull area but they have run an operator services Department since they were established in 1904. One of these services is handling any incoming emergency calls from anywhere in the Kingston Communications network, which is 120 square miles in and around the city of Kingston-upon-Hull.

They operate under the Fixed Network CoP and handle approximately 200,000 calls a year, all operators are trained to handle emergency calls. Kingston Communications pass calls to Humberside Fire Brigade using the primary, secondary or alternative numbers.

4.4 Telephone Number Portability

Telephone number portability means that subscribers can keep their existing number when they change phone companies.

Portability was proposed by OFTEL to eliminate the problems and expense (mainly for business customers) of changing a phone number when changing from one licensed operator to another.

Agreed procedures between the Emergency Services and the PTOs (before number portability trials on the fixed networks took place), ensure that customer addresses are always available for use on emergency calls during the transfer.

Licence modifications are now proposed for the mobile networks, this means that from January 1st 1999 portability will be extended to mobile phones.

The ability to obtain customer record information on mobile networks will become almost impossible.

Portability will be between mobile and mobile or fixed and fixed networks. There will not be convergence between the two systems for the foreseeable future.

4.5 Emergency Text Telephone Service for the deaf

Typetalk - (DCOL 6/ 1995, DFM 5/1995)

The Director General's OFTEL Advisory Committee on Telecommunications for Disabled and Elderly People (DIED advised that all involved in the 999 service should take account of the need to establish uniform access to the emergency services for people with severe speech and hearing difficulties.

To that end the Text Users' Emergency Service was launched in March 1995.

Run by Typetalk, which is part of the RNID, and funded by BT, it gives deaf, deaf and blind, deafened, hard of hearing and speech-impaired people access to the Emergency Services. A deaf or speech-impaired person who is unable to use an ordinary telephone uses a textphone, which is like an ordinary phone but has a keyboard and screen, to dial the Typetalk Text Users' Emergency Service on **0800 112 999.**

Figure 43 Emergency text telephone for the deaf
(Photo: Typetalk)

Figure 4.4 Using a text phone.
(Photo: BT)

The operators employed by Typetalk are highly trained and fully familiar with the needs of deaf and other text phone users.

Typetalk procedure for dealing with incoming Emergency calls

(1) Receive call on Text Users Emergency Service (TUES) terminal. Emergency calls take priority over all other switchroom activity.

(2) Establish the number from which the call is being made.

(3) Establish the service required by the caller.

(4) Attempt to obtain name, address and location of incident if different from caller's address.

(5) On obtaining minimum information (calling line number and service required) dial out to the required Emergency Authority using BT 999 service and instruct BT to connect Typetalk to the EA for the calling number given.

(6) On connection with the EA, the Typetalk operator will relay the call between Text caller and EA by voice. BT operator will normally remain on line to monitor call and offer assistance with locations, etc.

The text side of all calls is recorded on disk for future review/investigation, if necessary.

Departures From Standard Procedure

In the event that Typetalk are not given the calling number by the caller, attempts will be made to establish their location. This allows for connection of the call to the appropriate EA using the county lists and direct connect-to numbers.

In the event of failed connections, or calls which go off-line mid-stream, the back up CLI (Calling Line Identity) printer is used to try and establish the calling number. Attempts will be made to contact the calling number. If contact with the caller is not successful a call is made via the BT 999 service to the Police control for the area of the calling number to report a failed Emergency Call.

It should be noted that the CLI is not always received. It may be suppressed by the caller, or be from a network which does not share CLI with the BT network.

The service is tested at regular and frequent intervals. This testing involves Typetalk and BT responses, EA's and BT are not informed of the times of any test calls.

4.6 Emergency calls from the Railway Industry Network

Since British Rail was fragmented into a number of different companies and franchises the collective term used is the 'Railway Industry'. The railway industry has it's own telephone network - the Extension Trunk Dialling network (ETD) operated by RACAL-BR Telecommunications Ltd (RBRT).

The ETD network is almost exclusively used by railway personnel although, in some circumstances, possibly an emergency situation, it could be used members of the public. Dialling 999/112 from this network connects the caller to an RBRT Operator, not to a BT Operator Assistance Centre. To avoid any confusion all RBRT phones are clearly marked.

An Emergency Call is defined as a call from any source, concerning an incident, for which the caller requests the assistance of any of the Emergency Services. Emergency calls will only be answered by RBRT Operators who are trained and certified as competent to do so, all emergency calls will take priority over any other call and acted upon even if it is a repeat call.

There are currently five designated Switchboards which would normally receive emergency calls, these are at Crewe, Glasgow, London Waterloo, Swindon, and York.

Emergency calls from any part of the country could be received at any of the designated Switchboards. The operator begins by asking which service the caller requires and the location of the incident. Location details are entered into the Telephone Operators Directory System (TODS) which will show the primary and secondary connect-to numbers of each Emergency Service Control Centre. Emergency calls on this network will almost always originate from a railway location, although it is possible for the switchboard to receive calls from non-railway locations. In this situation locational information is unlikely to be found on the TODS database and the RBRT Operator will endeavour to obtain enough information (such as the nearest town, etc.) to correctly route the call.

If the EA primary number is unobtainable, or not answered within 30 seconds, the RBRT Operator will try the secondary number. If this is not answered, or is unobtainable, then the call is passed to the Civil Police. The number given by the RBRT operator is an ex-directory emergency ringback number.

RBRT will remain on the line until the EA operator has all the required information and the call is complete.

All details of emergency calls are recorded on an Emergency Call Record Form which is kept for one year, as well as recorded on audio equipment and kept for one month.

4.6.1 Payphones

The card payphones situated on trains for public use are not part of the ETD network. These 'phones are GSM 'phones which accept prepaid 'smart' phonecard and credit cards. GSM public payphones are also installed on some domestic coaches, Scottish and cross channel ferries and Eurostar trains. Phones on the cross channel services have the added facility of 'roaming' onto the French and Belgium GSM networks.

It should be noted that it is not possible to make 999/112 calls from these payphones. The phones are clearly marked to inform the public that 999/112 calls are barred.

4.7 Cellular communications

Cellular radio is a telecommunications service which allows people with mobile phones to make and receive 'radio' telephone calls within the service area to and from almost all national, international and other mobile phone network numbers.

In the early 1980's Government and Industry concluded that British business would be handicapped without adequate mobile communications. To this end cellular licences have been granted by the Department of Trade and Industry (DTI) since June 1985.

The cellular licence issued by the DTI and monitored by OFTEL prohibits some network operators from dealing directly with customers. This has created a complex multi-tiered market structure comprising of Service Providers, Dealers and High Street Retailers.

This complex structure has implications when trying to trace an abandoned call on a cellular network.

The original cellular 'phones were analogue but by 1997 there were twice as many digital phones as analogue, many of them utilising 'Global Systems for Mobile Communications' (GSM).

The history of GSM started in 1978 at the World Administrative Radio Conference (WARC) where the radio frequency band for cellular mobile systems was agreed upon.

In 1982 a committee was set up to ensure that the frequencies allocated to cellular radio were being used correctly and to co-ordinate plans for a European standard. This committee was called 'Groupe Special Mobile'', the European standard has taken its name from this committee, hence GSM.

In 1987 twelve countries agreed to sign a Memorandum of Understanding to design and implement GSM. Work on the technical development of GSM continues through the European Telecommunications Standard Institute (ETSI). In 1990 the GSM initials were changed to represent the new title 'Global Systems for Mobile Communications'.

GSM, now considered an international standard, was developed to ensure compatibility across cellular networks, allowing mobile phones to operate in different countries.

GSM means there will be an increasing number of overseas customers using their mobiles on UK networks ('roamers'). 'Roaming' may cause problems in tracing silent or difficult emergency calls. Although the mobile number will inform the British PTO of the caller's country of origin, any trace can only be done by dialling the caller back. The call will be routed via the country of origin which has cost implications for EAs and PTOs. Additionally, many 'roamers' have incoming calls barred because the cost of the call from their country of origin is charged to their own number.

It is unlikely a call from a 'roamer' could be traced. Therefore, it is reasonable to consider these calls un-traceable.

4.8 Cellular 999 services

The cellular operators 999/112 call service is based on six northern Operator Assistance Centres (OACs). BT handles all 999/112 phone traffic for Cellnet, Vodafone and Orange. One2One emergency traffic is handled by Cable & Wireless.

Cellular network companies found several problems that had not been experienced to such a degree with the fixed networks. To help overcome these problems a Code of Practice was devised under the auspices of the Home Office 999 liaison Committee - The Public Emergency Call Service (PECS) for Mobile Radio 999 Emergency Access.

When a 999/112 call is generated on the cellular network, it is received by the base station providing the strongest signal, generally this will be the nearest cell site to the location of the caller. However, because the transmission is radio, several conditions may influence where the signal travels to i.e., local topography, poorly positioned aerials on vehicles, or weather conditions. Also the fact that cellular frequencies travel exceptionally well across water add to the contributing factors.

The incoming call will be transferred to the fixed network providers through their OAC's and presented to the Operator by means of a 4 digit zone code. Zones roughly mirror county boundaries and are used to direct the call to the correct emergency authority. The zone code accesses the OAC's database and produces the connect-to-number for each of the emergency services.

Mis-routing of cellular calls generally happens because of the reasons stated earlier. It is also not possible to impose the same boundaries as with a land line system, this is especially apparent in rural regions where one transmitter may service quite a large area. With the growth of the Cellular industry and zones becoming smaller, the occurrence of long distance mis-routing is likely to become less common.

The mobile companies recognise the difficulties incurred by the Emergency Services when a call is mis-routed. To keep these mis-routes to a minimum, they require the emergency authorities to inform the mobile companies when a mis-route has taken place to enable then to investigate the circumstances surrounding the call.

The final responsibility for the overall correct routing of 999/112 emergency calls rests with the cellular companies.

4.8.1 Name and Address Information of Mobile Callers

The licence agreements of Cellnet and Vodafone restrict these companies from dealing directly with subscribers, their services can only be bought through Service Providers.

Although EA's require 24 hour access to subscriber records, the records of Cellnet and Vodafone customers, who have purchased their mobile telephone from an independent Service Provider, are not always available on a 24 hour basis. The Service Providers are not obligated by their licence to provide 24 hour access to customer information. Therefore, it may be difficult to follow-up a 999 call which has been interrupted or terminated in suspicious circumstances.

The Federation of Communication Services (a trade association of the mobile communications industry) have informed OFTEL that it is not commercially viable for all Service Providers to provide 24 hour access given the small number of cases involved.

The licence agreements of One2One and Orange enable them to supply their customers directly. Therefore, most of their subscriber information is available on a 24 hour basis. Only a small percentage of their customers use High Street service providers.

It should be noted that licence agreements are subject to change. However, Brigades will be kept informed of all 999 issues through the 999 Liaison Committee.

Subscriber information for Cable customers is held by BT and Cable & Wireless.

4.8.2 Release of Subscriber information

The principles and procedures applying to the recording of calls, and the release of subscriber information for emergency calls originating in any mobile network, is the same as those applying to emergency calls originating in the fixed network.

All the cellular 999/112 services work in much the same way. Therefore, a detailed description of one system may be helpful.

4.8.3 System Description - ORANGE

Orange Personal Communications System (PCS, sometimes referred to as Personal Communications Network (PCN)) use BT's facilities to connect 999/112 calls to Emergency Authorities Control Centres (EACCs). All 999/112 calls generated from the Orange digital network will be routed to one of six BT Operator Assistance Centres from one of thirteen Orange switches, each of which has a minimum of two routes into BT's network. Routing design within Orange ensures that 999/112 calls are sent to BT at the originating switch first, followed by alternative routing throughout the total network. This guarantees delivery of a 999/112 call in all cases, barring a major network disaster within Orange.

The principle behind Personal Communications Networks (PCNs) is the multiple re-use of valuable radio channels. The country is divided up into a series of 'cells', each served by its own low powered transmitter/receiver (base station). Each of these base stations is assigned a set of frequencies differing from those assigned to adjacent cells. The resulting pattern can be repeated enabling radio channels to be used again but geographically far enough away to prevent interference.

The very nature of the provision of radio telephone communication means that users do not necessarily know their exact location and the radio communication system cannot pin-point the caller either. The resultant problem in a cellphone user having to detail this information when making a 999/112 call is likely to lead to delays in satisfactorily reporting particular incidents. However, in every case the caller should be asked to state their location.

4.8.4 Cell/EA Boundaries

Comparison of cell site boundaries and EA boundaries shows that cell boundaries are unlikely to overlap more than two adjacent EA coverage areas. Where a cell coverage area straddles two or more EA coverage areas, a particular EACC will be agreed and nominated, to which 999/112 calls from that cell are to be directed.

4.8.5 Routing 999/112 Calls to EACCs

To enable the Operator to connect a cellphone 999/112 call to the correct EACC, a map of the UK

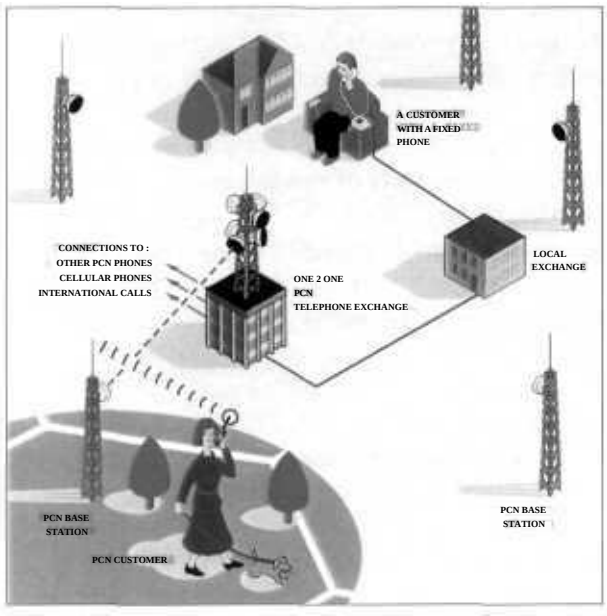

Figure 4.5a

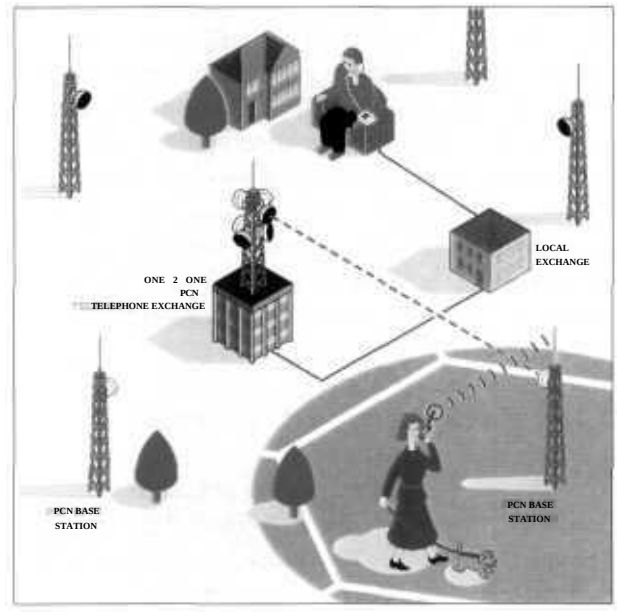

Figure 4.5b

Figure 4.5 Ax the caller moves around between cells, the PCN system automatically switches the signal between base stations without interrupting the call.

(Graphic: One 2 One)

with EA zone code areas has been created. The EA boundaries generally follow county boundaries. Each cell within the agreed EA boundaries is mapped to a four digit zone code, (Orange zone codes are prefixed with '3'Cellnet zone codes are prefixed with '2', Vodafone zone codes are prefixed with 'O'). Each zone code will be mapped by BT to the four EAs within the boundary area, each of which will have advised the PTO of primary, secondary, alternative and evacuation EACC connect-to numbers.

On receiving a cellphone 999/112 call, the BT Operator's console displays the caller's number (CLI) and a zone code which identifies the originating base station. A list of EACC connect-to numbers corresponding with the zone code is automatically displayed for selection by the Operator.

4.8.6 Cell ID Look-Up Failure

Failure to display an EACC connect-to number on receipt of cell ID/zone code information is extremely unlikely. However, should this occur the Mobile Operator will tell the cellphone caller that there is a network fault and that some information checking will be necessary. Orange will locate the origin of the call by determining the cell ID, using its inherent network facilities. Once the cell ID is provided, the Mobile Operator will refer to a look-up table and forward the call to the corresponding EACC. This call tracing facility can only be carried out if the calling cellphone holds the connection. Post event traces are not possible but records are kept by Orange which include time of call, duration, originating cellphone number and the cell which received the call. These records are kept and available for cross-checking for approximately three months.

4.8.7 EACC Connect-to Numbers

The EAs should aim to provide at least two weeks notice of changes to primary, secondary, alternative and evacuation connect-to numbers to the relevant PTO and mobile operator, who will follow their mutually agreed update procedure. The date and time that the new numbers become effective should also be stated.

4.8.8 Misrouted Calls

Base station radio reception areas cannot be sharply defined or matched exactly to EA boundaries. Therefore, for some base stations, it is inevitable that a small proportion of calls will originate outside the boundaries of the agreed EACC. Also, there are several other reasons why the base station handling the call may not be the closest to the incident i.e.:

- The caller is moving and delays reporting an incident.
- A distant base station across water can sometimes provide a stronger radio path than a closer one on land.
- If the caller is in the radio shadow of a hill or large building, a more distant base station may be selected.
- Cellular radio signals can travel long distances in certain weather conditions.
- The nearest base station is already fully occupied.

It is also possible that the cell ID could give an incorrect but apparently valid code to the Operator due to a faulty console or a fault in transmitting the display information from the switch.

Once connection is established to the EACC, it is the responsibility of the EA operator to establish that the call is relevant to the EA area, or to instigate means of transfer if it is not.

This can be achieved in a number of different ways:

- In most cases the EA will take the details of the call and pass the information on to colleagues in the correct authority.
- The EA operator may recall the Operator back into circuit and request that the call is passed to another EACC. This may be a different emergency service.

- The EA operator may advise the Operator of the correct EA to handle the call. The Operator will then look-up the appropriate connect-to number.

If it is not possible for the EA to advise the correct connect-to number, or even the correct county, then the Operator will instigate a call trace procedure as described, resulting in Orange providing the location where the cellphone accessed the Orange network. The Operator will then re-route the cellphone customer to the applicable EA.

The ultimate responsibility for redirecting the call to the correct EA, however, will rest with the operating company who will take all reasonable steps to do so.

4.9 The satellite telephone

World-wide communications cover is now a common form of communications which is readily available to all, by way of the Inmarsat-Phone, which is capable of transmitting both voice and text data. It would be true to say, however, that until recently many brigades felt that such systems were out of their reach due to the high cost factor in providing the equipment, together with the unit cost of calls. The situation has changed quite dramatically over the past few years, in that satellite communications is now considered an every day form of transmitting data. The present day equipment is both readily available at a reasonable cost for its provision and use.

Figure 4.6 Satellite telephone.
(Photo: Inmarsat)

Such a system of communicating has been employed by some UK brigades in the past, most notably when a system was obtained on loan and used successfully, by members of UK Fire Brigade Search and Rescue Teams whilst in Armenia, following the earthquake disaster. Some Fire Brigades in Europe regularly use satellite telephone systems as an acceptable form of communication and their specialist rescue units carry it as part of their normal equipment.

The modern range of satellite communications systems offers a light and compact package of equipment which can be set up and ready for use in a matter of minutes. It is also true to say that it is a reliable form of communications which is simple to use from anywhere in the world.

4.10 Public Warning and Information by Telephone (PWIT)

Nowadays more then 93% of households have a telephone and it is seen as an essential mechanism for communicating with customers, colleagues, friends and relatives as well as the emergency services. Telephones are increasingly used to obtain a wide range of information, why not use them to disseminate information as well?

There has always been a need to alert the public about threats to their safety or provide information services at times of major disaster. These disasters can, for example, take the form of flooding, hazardous chemical leaks or even freak weather conditions. Traditional warning methods involving sirens, police with loudhailers or broadcasts from local radio stations have proved not to be particularly effective.

Early in 1996 the Home Office asked BT Tallis Consultancy to investigate how the public telephone network might be used to warn and inform people about impending life threatening incidents at any time of the day or night.

This investigation also considered the potential of improving information services to the public following a major incident. Experience has shown that special telephone numbers broadcast for use by anxious relatives and friends seeking information about an incident often result in considerable delays in obtaining the information.

Also in 1996 the Environment Agency awarded a contract to Kingston Communications to develop a flood warning system which would alert people vulnerable to flood danger to enable them to take necessary action to protect themselves and their property. The warning system would also have to notify the police, emergency services and local authorities.

The autodial system designed for the Environment Agency by Kingston Communications is capable of sending urgent telephone, facsimile and pager messages at the rate of approximately 1600 calls an hour using 30 outgoing telephone lines and two facsimile machines on each line.

Kingston technology is scaleable and a system can be designed to accommodate any requirement.

Whichever telephone warning system is used it will almost certainly be backed up with warnings issued through the media.

Following a BT feasibility study, competed in 1997, a National Steering Committee has been set up to investigate the possible options of using the national PSTN network for civil 'disaster' warnings. The steering committee includes representatives from Central and Local Government, Police Fire and industry (mainly petro-chemical companies), as well as consultants from the telecommunications industry.

A trial of public warning systems by telephone is expected to go live in Cleveland during 1998. This is an area with a large concentration of petro-chemical industries, and although the trial could cost over £1 million this would only be a small proportion of the compensation costs of a local disaster.

Public warning by telephone is very new and, unless each recipient pre-registers, gives rise to a number of the regulatory and data protection issues. These have now been addressed and OFTEL's view is that unsolicited automated calls may be used for emergency messages (e.g., where there is threat to public safety or their property).

The police, after consultation with industry or other emergency services to asses the risk and decide what action should be taken, would give authority to alert the public via telephone.

4.10.1 How the proposed BT'PWIT' system would work

Select an area. It is expected that the police (as prime users) would use a Geographical Information System (GIS) to make use of digitized Ordnance Survey maps displayed on a PC screen. This enables an operator to zoom into a specific area and draw a radius or plume, select specific premises or streets, select zones liable to Hooding, etc. The selection is then translated into Ordnance Survey co-ordinates to delineate the required area.

Input the message. The police (with advice from an expert on the hazard) would initiate the emergency warning message which may be spoken into the system, or typed into the computer keyboard.

Send the request. The selected area (in the form of the Ordnance Survey co-ordinates) and the message are sent electronically over a phone line to the BT distribution centre. Databases are interrogated to determine the telephone number of all premises in the selected area (including BT, Cable and Wireless, cable TV operators, etc.). A large computer system called a Speech Application Platform is used to convert text to speech, where the message has been input as a text message, call all identified telephone/FAX/pager numbers and monitor the progress of the calls.

The system could also alert mobile phones which are active in selected cells, and possibly even send text messages to mobiles using the short message service (SMS).

Act upon the response. Acknowledgement of the message is requested by use of the telephone key-pad or by speech recognition. The system will provide a continuous update on acknowledged calls, engaged tone, no answer, answering/fax machines, calls which have been answered but not acknowledged, etc.

As an additional feature, the message and a list of telephone numbers may be sent to the Speech Application Platform for delivery by BT. This enables numbers which are held on a database (but not geographically clustered) to be called by BT.

Public Warning by Telephone Systems enable calls to be made very quickly to any selected area anywhere in the county and enables positive confirmation of receipt of the warning. These systems are more suitable for modern, localised threats and would not be suitable for alerting millions of people as would be required under war conditions.

Chapter 5 - Control Centre equipment

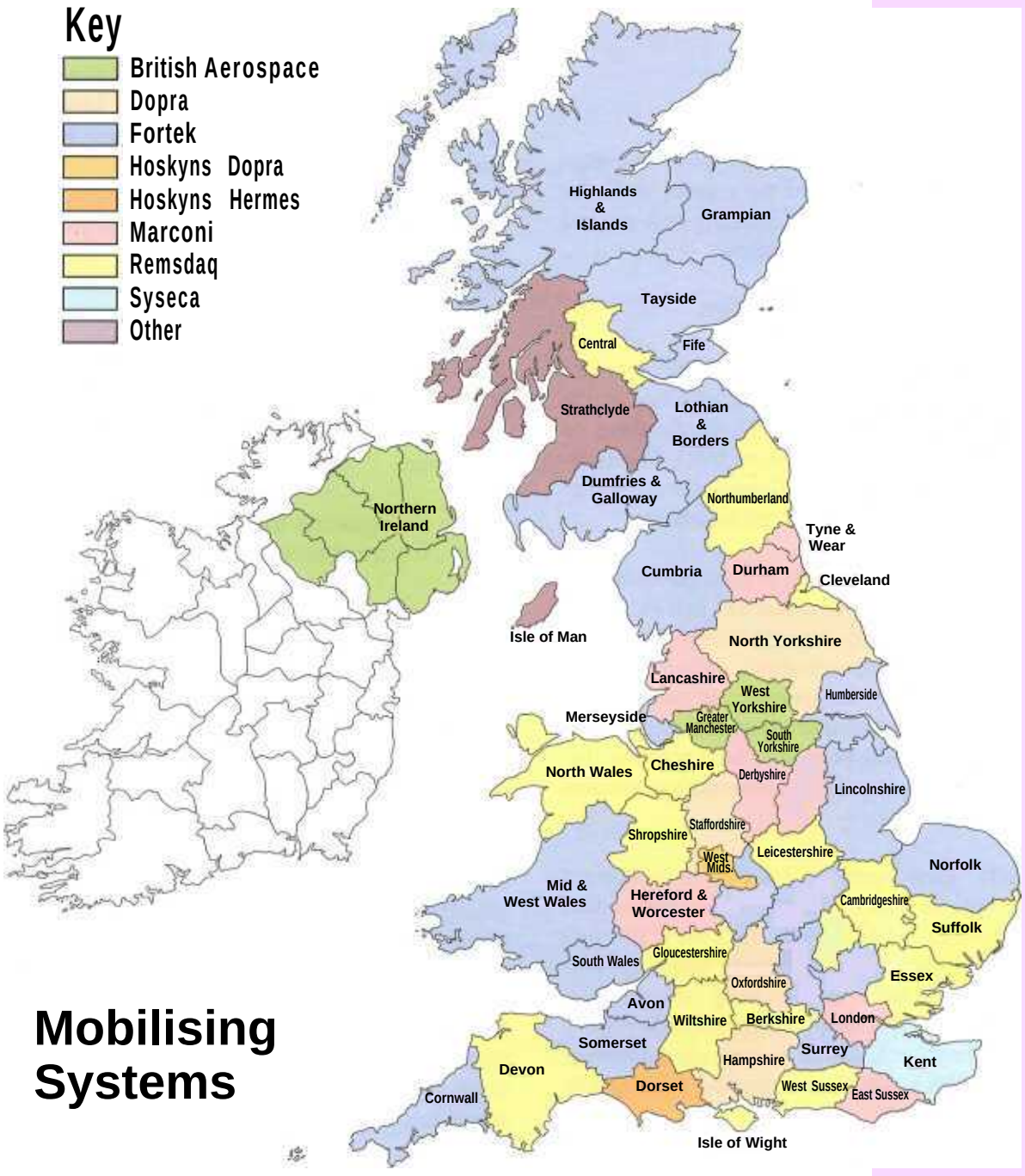

Figure 5.1 Mobilising Systems used by Brigades — June 1998.

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All Fire Services now use computerised mobilising systems to support the call taking and mobilising procedures. These systems comprise several main elements:

- Integrated Voice Communication Switch.
- Computerised Mobilising System.
- Communications Interface.
- Bearers.
- Station End Equipment.

Integrated within the mobilising system are other optional features which aid the control staff, for example, resource displays, mapping systems and automatic vehicle location systems.

5.1 Control Centre Design

A comprehensive guidance document for Fire Service Control Centres has been published by the Home Office in DCOL 8/1997, in Scotland as DFM 8/1997 (FRDG Publication 2/97). The document includes advice on the Control Centre design & ergonomics, procurement and legislation.

The most common workstation configuration for a Control Centre Operator comprises two PC terminals, one connected to the mobilising system and the other to the communications switch. Through these two terminals the operator can carry out all mobilising and communications tasks. In some cases a third PC will be used to hold resource display maps and geographical information systems (GIS).

Typically, each operator position in a Control Centre will be fitted with the same workstation configuration and system facilities through which the basic tasks of message handling, logging and resource despatching are carried. Occasionally a specially configured supervisory position may be installed to provide additional facilities such as special monitoring functions or access control, etc.

5.2 Communications

5.2.1 Administrative Communications

In centralised mobilising schemes there are considerable advantages in segregating administrative communications systems from operational systems, though it is common for links to be provided between them to give flexibility of usage. The main advantages of this principle are firstly that the operational systems can be much simpler and more easily duplicated at a number of operating positions, and secondly that both operational and administrative systems can be operated simultaneously at maximum capacity at any time without causing mutual interference.

In the majority of Control Centres segregation applies. The administrative PABX telephone switchboard is usually in an ideal situation elsewhere than in a Control Centre and operated by non-uniformed staff during normal office hours. After office hours, however, when the switchboard is closed, incoming calls are switched on 'night service' extensions to terminate on Control Centre equipment.

5.2.2 Safeguards for Emergency Communications

The mobilising scheme should have been planned so that it is not seriously affected by congestion, either in the Control Centre or on its communications systems. It should also be able to function normally and without interruption in the event of a mains electricity supply failure, either locally at fire stations, or centrally in the main Control Centre. Either the central control should be safeguarded so that there is virtually no chance of a complete breakdown there or, alternatively, there should be arrangements made for a secondary control to take over in the event of a serious failure of the main control or its communications.

There are, however, technical and economic problems involved in choosing, equipping, staffing and keeping an alternative control centre in being, solely for the use in the event of a breakdown at the main control. The general practice has, therefore, been for the fire authority to invest available financial resources in a highly reliable communi-

cations system and in safeguarding the central control to the maximum possible extent. These safeguards normally include:

- Diversified communications bearers.
- Standby power facilities which automatically come into operation immediately in the event of failure of mains electricity supplies.
- Adequate fire precaution arrangements e.g., smoke detectors in communications apparatus rooms and also in plant rooms and roof spaces which are normally unattended and are a potential risk.

Finally, there should always be predetermined and practiced last-ditch arrangements, including the use of radio and of pre-arranged telephone contacts. At fire stations there should be an emergency un-interrupted power supply (UPS) to maintain computer and turn out equipment. It is essential for Control Centres to have an uninterrupted power supply and emergency power generator facilities.

5.2.3 Provision of Suitable Circuits

The mobilising 'scheme' should not rely totally upon access to the public telephone network, since this may become congested due either to peak normal usage or to the direct effect of a flood of emergency calls to a large incident.

Whilst, in the past, fairly widespread use of the public telephone network was made by Fire Services for remotely controlling fire station alerting systems, this practice was generally speaking, only acceptable when mobilising was decentralized on fairly small units such as districts or divisions. Nowadays, due to the automation of the telephone network and the rapid expansion in the amount of telephone traffic, it is no longer regarded as satisfactory for emergency call-out purposes. Therefore,the primary bearer could be kilostream, ISDN, radio or a commercially available public-data system such as RAM or Paknet. Whilst the secondary bearer should be independent of the primary bearer it could be ISDN, radio, data radio, or PSTN.

Some Fire Services also have a tertiary bearer and utilize a commercial paging network to operate the firefighters callout system. Other Brigades use an overlay paging scheme on the Brigade main scheme radio as their tertiary bearer.

So far as the initial connection of 999/112 emergency callers is concerned, it is important that adequate facilities are provided to enable telephone operators to do this very quickly. The introduction of digital exchanges 999/112 services are provided over PSTN lines between Operator Centres and the emergency authorities, these lines being safeguarded by allowing sole access by the Operator Centres. As a standby against breakdown of these circuits and for use during peak periods, a number of ex-directory exchange lines are provided in the Control Centre where they appear at all operator positions together with the trunk-subscriber circuit terminations.

5.2.4 Alternative Routing of Cables

To minimise the effects of a possible breakdown, the scheme should always include what is known as 'true alternative routing' of the lines serving the central control building, i.e., the provision of at least two separate cables in different cable duct routes. This principle should extend, so far as is practical, to all fire stations particularly where important or 'key' stations are involved. At the central control end, essential operational circuits used for receiving incoming emergency calls and for remote control call-out facilities should be equally divided between the different duct routes so that, if one of them is interrupted e.g., due to flooding, at least half of the circuits remain in operation.

5.2.5 Monitoring of Remote Circuits

The circuits which carry remote control facilities, which are the essential backbone of any mobilising scheme, should always be of the monitored type. These give automatic indication to the Control Centre operators of faults as and when they develop on the network, enabling immediate action to be taken to get the faults rectified and to implement predetermined alternative arrangements for alerting the affected stations or personnel.

GD92 can be set up to generate traffic which tests the bearer at regular intervals. The timing of these test signals is set on installation and can be determined by the brigade.

5.2.6 Exchange Telephone Lines

Exchange telephone lines are commonly used in Control Centres and terminate either on telephone instruments, telephone switchboards, line concentrator units or a digital switch linked to a touch sensitive screen. Some are earmarked for exclusive operational use whilst others are for administrative purposes.

The common tendency is for the operational circuits to be terminated on line concentrator units or a digital switch and the administrative circuits to be terminated on a PABX switch so that calls may be connected to extensions throughout the organization. A PABX or private branch exchange is a semi automatic switchboard that allows the majority of connections via the PABX to be dialled direct by the extension users, and also may allow external callers to directly dial the extension. The function of the switchboard operator is then mainly confined to answering calls on the main switchboard numbers where the caller is unaware of the extension number or answering queries from callers on the internal extensions.

5.2.7 Operational Lines

Where a number of exchange lines serve a Control Centre it is usual for them to be 'ex-directory', under which arrangement the numbers are not disclosed to the public. It is advisable to keep at least one free for outgoing calls or have these numbers allocated as incoming calls barred lines. It is not uncommon to apply the facility of 'auxiliary working' to such groups of exchange lines, so that when the first numbers or lines of the group are in use, the caller is connected automatically to one of the free numbers or lines in that group.

However, one disadvantage of this arrangement, when applied to operational lines in a centralised mobilising scheme, is that certain fault conditions in the telephone exchange might put all the lines of the group out of action.

It is highly desirable, therefore, to split the emergency and the administrative lines between telephone exchanges so that they would not all be affected by one fault.

5.2.8 Line Concentrator Units and Digital Switches

Line concentrator units allow the operator to accept a call from whatever source with a single action, and are more convenient to use than a number of telephone instruments. These units can accommodate a variety of types of termination including exchange lines, private wires and telephone extensions as well as control terminations for the various facilities on Fire Service radio schemes.

These units can easily be repeated, each with identical terminations and facilities at any number of operating positions in a Control Centre, to facilitate the simultaneous handling of a number of different calls during busy periods. The termination of all operational circuits on concentrator units avoids the unacceptable bottleneck which would be created if a conventional type of telephone switchboard was used.

Where concentrator units are repeated, an incoming call is indicated at all positions with a flashing lamp signal. When the call is answered at one position, the flashing signal on all other positions changes to a slow wink on the lamp, which indicates that the call has been accepted and that the circuit is engaged until the lamp goes out.

The unit is also suitable for use when monitoring facilities are required e.g., to enable a supervisor or Officer-in-Charge to listen in to calls and to break in and assist when necessary. The same terminations and facilities as on the operational position units appear also on the supervisory position units, and the circuitry can be so arranged that the action of 'listening in' does not degrade or in any way interfere with the call.

The line concentrator unit is being superseded by a digital switch that incorporates duplication of all key elements of the switch. Most switches use a PC and 'touch screen' which is linked to the switch via a high speed local area network or a serial link.

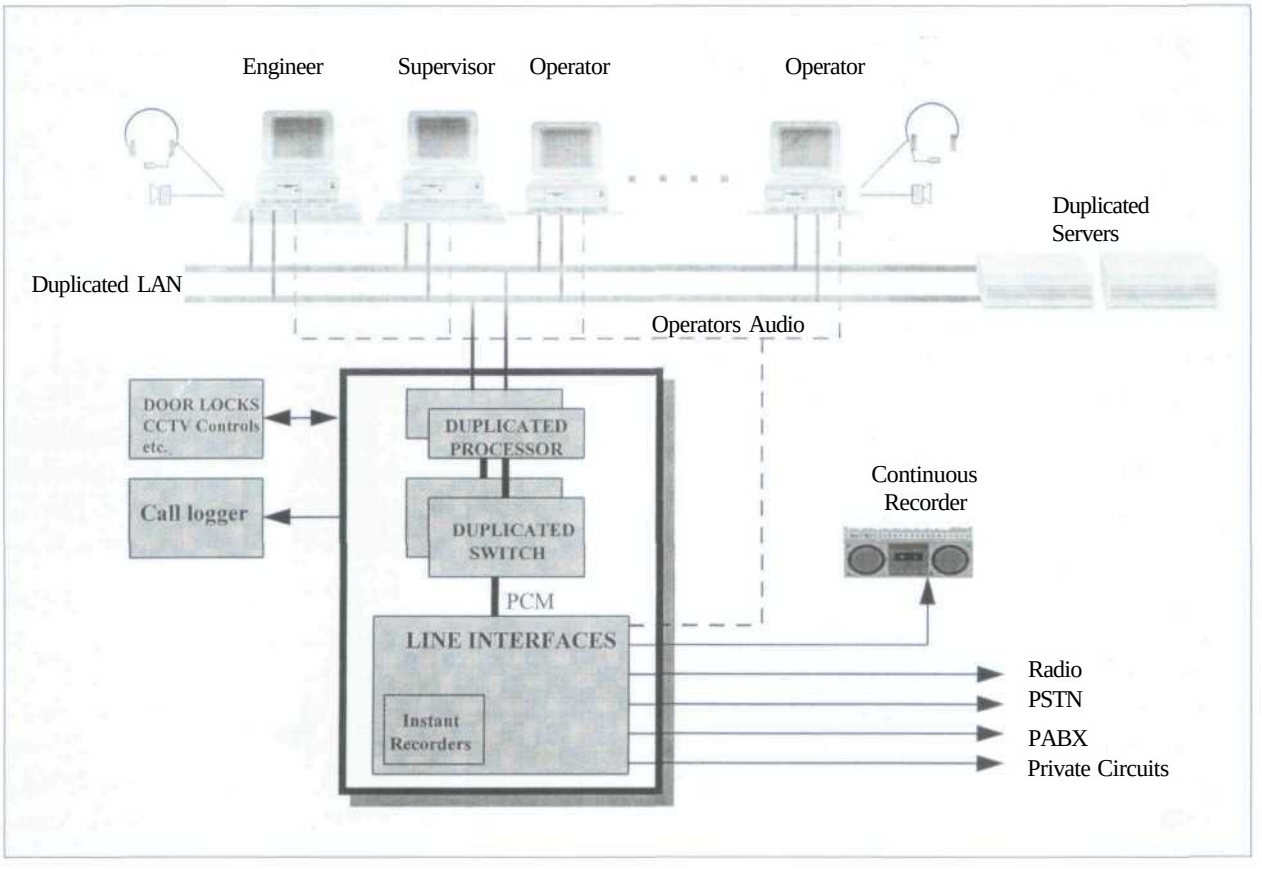

Figure 5.2 Architecture of typical Integrated Communications Control System (ICCS). (Graphic Securicor information Systems)

Many are Integrated Communications Control Systems (ICCS) which incorporate both telephony and radio functions.

Figure 5.3 A touch screen in use in a Control Centre.
(Photo: Simoco)

Different levels of access are available for operators, supervisors and maintenance staff.

Operator access to the system is by means of a touch screen colour which displays coloured representations of press-buttons. **When touched, the system responds and begins a series of operations related directly to the selected button to provide full control and status displays of all radio and telephone functions.** Most switches are capable of queuing incoming calls and, if necessary, present the operator with the oldest call first. This is especially useful during spate conditions when emergency calls may be waiting on the system.

The high speed local area network interconnects operator positions and the central switch. This network broadcasts simultaneous updates to all positions and whilst performing particular functions, the operator is able to call up information from the system's database including relevant help messages and telephone directories. In addition, each operator position has access to all the facilities

provided by the line concentrator units such as call monitoring by any other position, intercom and indication of line state and extra facilities such as a system database, recording and playback facilities and configuration of both telephone and radio facilities.

Communications switches either have an integrated call logging facility which can be accessed through an RS232 port to an engineering terminal, PC or separate printer, or the ability to connect an independent call logger. These PC based systems provide flexible report generation and the ability to customise information presentation of all telephone and radio traffic.

Open interface capabilities give the flexibility to connect external devices including CCTV, lighting systems, door entry mechanisms and alarm systems.

5.2.9 Automatic Call Distribution

An additional function of call handling equipment is Automatic Call Distribution (ACD). Incoming emergency and administrative calls are automatically presented to available operators on a highest priority basis. Each call in the queue is presented to the first operator that releases a line and is available to accept the next incoming call. An electronic tone is transmitted to alert the operator that they have be allocated a call.

When the call has been completed the operator is allowed a pre-defined amount of time in which to carry out other essential actions. The system will automatically present another call when the lapsed time is reached. Alternatively in cases where a number of actions are required a manual option to 'suspend' the operator from the system is available.

This system is more likely to be used in larger brigades and has recently been installed in London.

5.3 Computerising Mobilising System

Clearly the primary Control Centre tasks of incident logging and resource availability are team activities which require all operators to have access to the same information.

A variety of mobilising systems are available to brigades and may be known as either Computer Aided Mobilising Systems, Command and Control Systems or Mobilising and Communications Systems. All these systems are, as the name suggests, systems which incorporate computers to aid the reception and logging of calls and the despatch of the brigades' resources to incidents.

The incident and resource information recorded on the mobilising system is of interest to a number of departments outside of the Control Centre e.g., statistics, Press Officer, etc. Much of the information required by control may be prepared or maintained by other departments and, hence, database update facilities must be made available to these departments.

An operator or supervisor's workstation will have a visual display unit (VDU), a keyboard and often a "mouse' to provide access to the mobilising computer. The keyboard may be a standard typewriter (QWERTY) layout or a standard keyboard with some of the key functions changed to dedicated functions.

5.3.1 Mobilising System Functions

The main function of the mobilising system is to aid the recording of call information and the despatch of the selected resources. Secondary functions include displaying alarm conditions for the system and the generation of statistical information.

Upon entry of an incident type and address into a predefined format the system will interrogate its database to match the address information. If an exact match is not found the system may offer similar sounding addresses to the operator. It may also search for risks, duplicate incidents, telephone kiosks, map references, etc., so as to provide the operator with as much information as is possible. When an address match is made the operator is presented with a pre-determined attendance and possibly a recommended attendance.

The operator is then able to accept the offered attendance, mobilise an alternative or defer the incident, placing it in an incident queue or merging it as in "same as all calls".

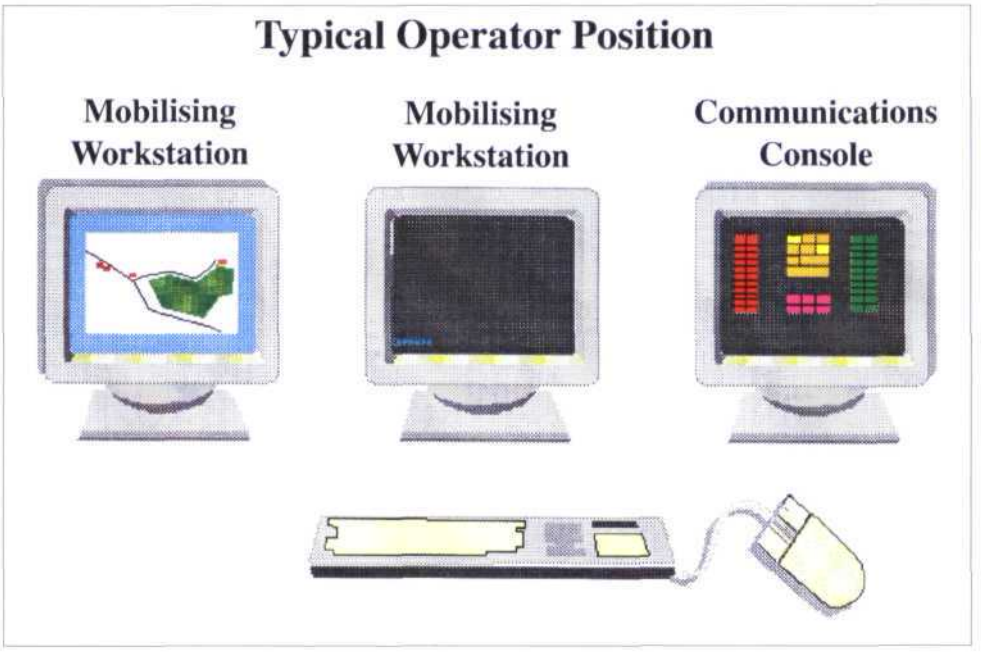

Figure 5.4 Typical Operator Workstation.
(Graphic: Fortek

To undertake these tasks the mobilising system accesses various databases that are part of the system, such as an address gazetteer, pre-determined attendances, risks, special procedures and CHEMDATA information. It also records the status of appliances and officers and will not offer resources that are already committed to other incidents.

It must be stressed that the system only makes recommendations which can be overridden by the operator. The mobilising system also maintains a log for each incident recording all the actions associated with that incident. Other logs are also maintained recording other aspects of the system not related to incidents, such as communication failures, operators logging in and out of the system, tests, etc.

Once the mobilising system has been used to set up and verify the incident details and proposed resources to attend, the turnout instructions must be conveyed to the appropriate fire stations and the crews alerted. The system will encode the data and deliver it to the communications network for onward transmission to the appropriate destination including automatic data recovery.

In most instances the communications network will comprise of a primary, secondary and possibly a tertiary back-up bearer. The primary bearer will be the most appropriate bearer for the station taking into account the number of calls and other facilities required, as well as available technology.

Secondary bearers should be independent of the primary bearer so that any failure will not affect both bearers. Examples of bearers used are Kilostream circuits, ISDN and PSTN telephone lines and radio links including dedicated data networks and brigade radio schemes.

The station end equipment must be able to receive and respond to control centre messages for turnout instructions from both primary and the secondary bearers.

In 1992 the Home Office produced a specification (known as GD92) for a standard communications protocol to be used for all operational communications between the control centre and the station end equipment.

The main objectives of the specification were that products could be procured by fire authorities under a Framework Arrangement and would be interoperable with other products from the same, or different, contractors. In addition, Brigades and contractors should be able to enhance the basic products without affecting interoperability.

The Framework Arrangement was able to meet the need for provision of equipment with the differing

capacities and performance required by different brigades whilst providing the benefit of economies of scale and boundary independence.

The specification was also beneficial to brigades procuring equipment outside the Framework Agreement.

GD92 defines a standard protocol and message format for mobilising systems over commercially available bearers. This protocol is now used by the majority of Fire Brigades.

For each of these bearers the protocols and message formats have been designed to ensure that the mobilising system and, hence, the operator, is advised of the delivery or non delivery of each 'turn out' instruction. The protocol supports administrative messages, equipment status messaging and other functions such as burglar and fire alarm activation, power failure and restoration messages, and tests of mobilising links to ensure their availability.

GD92 also supports two way messaging and, hence, station personnel can prepare messages locally and send them into control, the most common example of this being the entering of staffing levels at a change of shift.

Station equipment has become increasingly sophisticated and is generally controlled by a micro-processor or computer. The system will check the incoming data to ensure that it is valid and then undertake a series of localised actions which may include:

- Control of mains powered equipment such **as** lights, doors and exhaust extract.
- Signalling to crew alarms including audible alarms, alerters, appliance indicator lights.
- Confirmation to the control centre that uncorrupted data has been received, peripheral equipment has operated and crews have acknowledged.

In addition to this, they may also run self checking routines to ensure that they are functioning correctly, that the bearers are functioning correctly, and that other conditions such as mains power and battery status are monitored.

Mobilising system architecture generally falls into two basic categories:

(1) Central Processing; or
(2) Distributed Processing

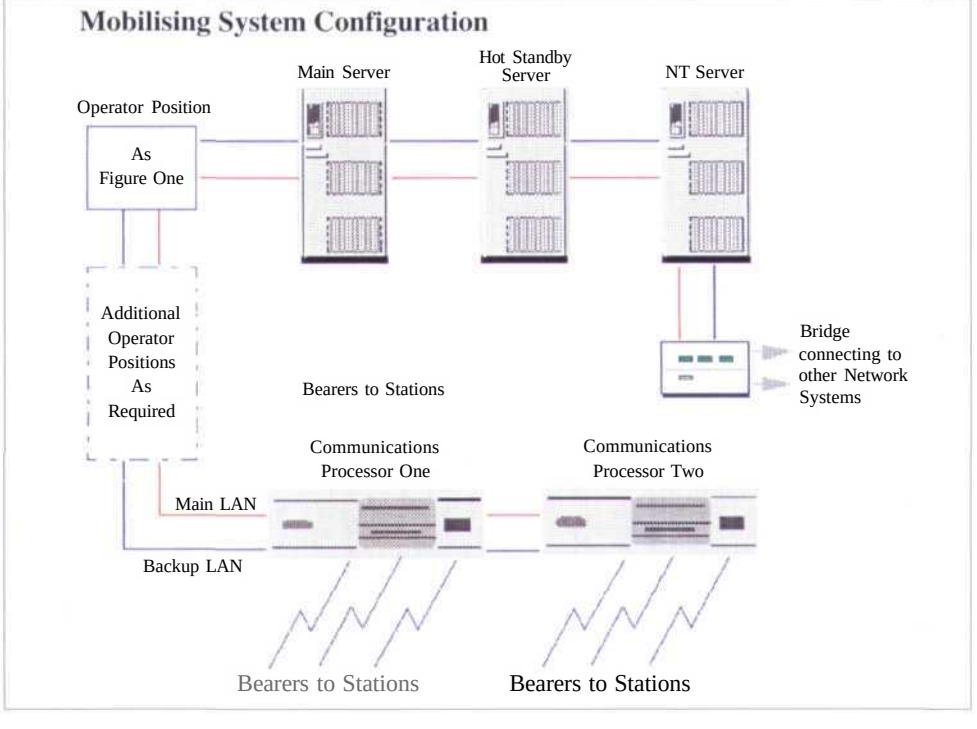

Figure 5.5 Mobilising System Configuration
(Graphic: Fortek)

The workstations and/or processors are linked together by means of a local area network thus providing a communications path to the various elements of the system. Redundancy is provided in the system so that failure of any particular element will not inhibit the mobilising process.

1 **Central Processing** - Various standard computer configurations can be implemented in a client/server system, consisting of PC workstations connected via a network to a server. The server requires an operating system that is not only able to support multiple work stations, but also has the processing capabilities of high level programming languages, systems such as 'Unix' or 'Microsoft NT' fulfil these requirements. In addition, processors are required to provide the communication interface from the mobilising system to the bearers and hence the station ends.

   Resilience is provided by incorporating redundancy within the system. Dual servers are provided, one operating as a 'hot' standby, i.e., the secondary server is continually being updated in 'real time' by the master server, so that in the event of failure of the master server the secondary server is able to take over the function of the master server.

   The secondary server may be in a different location within the same site, i.e., a different building within a control complex. This builds in some additional resilience in the event of system failure to the main control room.

   The communications processors are also duplicated but as these do not incorporate dynamic databases both are operating together but are able to mobilise the brigade independently in the event of failure of one of them. As the work stations are in effect 'dumb' terminals, failure of one workstation processor will not jeopardise the mobilising system but will only render that workstation inoperative. Again, it is possible that the communications processors are in different locations within the same site.

2 **Distributed Processing** - Workstation processors are connected by a local area network but in this configuration the work station processors are high level processors which hold all the data base information such as incident logs and PDAs. One processor is deemed to be the master processor and co-ordinates the processes of the other work stations. In the event of failure of this master processor, then another workstation can be designated as the master. Communications with other peripherals is carried out by other processors on the network, for example, each fire station has a processor on the network which is connected to the bearer interfaces.

It is desirable that local area networks used for mobilising should not allow access from other networks, this could lead to congestion or failure of the mobilising system by corruption.

Consideration should be given to protecting the mobilising local area network and providing appropriate 'fire walls' where necessary. With current technology it is possible to provide more than one network connection on a work station thus providing an operator with the presentation of information from different networks but not providing any interconnection of the networks.

Information required by other brigade departments, such as incident logs or statistical data, may be downloaded at pre-determined times or in 'real time' to another computer system for interrogation and processing. Conversely data may be retrieved from other brigade computer systems by the mobilising system for use in the processing of incidents.

5.4 Ancillary Control Facilities

5.4.1 Voice Recorders

Fire Services record incoming emergency calls automatically by using various types of voice recording machines ranging from the relatively simple single and multi-track tape machines to PC based digital recorders with automatic time injection. It is customary to devote an individual track on a multi-track machine to each workstation and derive the audio from the connections to the operator's headset enabling all land lines and radio channels in use at that particular work station to be recorded.

Although voice recordings are not used to assist turnout, they are nevertheless sometimes useful for verifying the accuracy of an address or other information. They are also used at subsequent enquiries to prove what in fact was said on a particular occasion both by the caller and the Fire Service operator. Recordings of emergency calls are frequently used as training aids to help trainees appreciate the problems in extracting adequate information from agitated callers. They are also used to aid identification of callers who have made malicious fire calls, and there have been instances where, when faced with a voice recording the culprit has confessed to being the originator of a false alarm.

5.4.2 Availability and Fire Situation Display

Every Control Centre must have, in one form or another, an accurate and up-to-date record of the location and availability of appliances, equipment and officers on standby for immediate turnout. This display is used primarily for ensuring that the resources of a predetermined first attendance are in fact available for despatching when an emergency call is received. It is also used as an aid to the Officer-in-Charge of the Control Centre when considering 'covering' moves to maintain an equal distribution of fire cover throughout the area during periods of intense activity.

Fire situation information throughout the mobilising area at any time must also be displayed, and this must be kept up to date and in step with the mobilising moves. The fire situation display would normally show the address of the incident, the appliances and officers attending, whether or not a stop message has been received and very brief information likely to be needed by Control Centre staff or senior officers.

The types of display used for these purposes vary a great deal in different brigades. The general practice in the past has been to use a combined general-purpose and appliances-availability wall map, with separate boards marked out for recording fire situation details. In such cases the map will indicate every available appliance by means of tallies or coloured lamps. It is common to find separate 'officer-availability' boards which indicate where an officer is and whether available by radio, pager or telephone contact.

When an appliance or officer leaves their station, whether it be to an incident, for drill or other purposes, the appropriate tally or lamp is deleted from the availability board or map and shown either on the fire situation display board in the case of an incident, or in an appropriate section of the mobilising board where provision is made to record appliances and/or officers which are not immediately available for operational use.

With the advent of computerised mobilising systems, the display of information from fire situation displays, appliance or officer lists, to PDAs and incident logs has become the norm at each operator position. The introduction of graphical information systems (GIS) has enabled displays similar in appearance to those presented by the traditional lamp system to be reproduced electronically. These resource availability displays, for both appliances and officers, are driven from the changes in status of the resources held in the mobilising system database. These displays can be presented at each operating position on a VDU and also projected on to a wall display, either from the front or the rear.

5.4.3 The Gazetteer

To receive and validate details of an emergency, an operator relies on a comprehensive gazetteer of streets and special locations and/or premises. All mobilising systems will utilise a gazetteer to validate the location of an incident, so clearly the speed and accuracy with which an operator can confirm the incident location will depend upon the quality and comprehensiveness of the gazetteer.

As a minimum it will hold a list of street names for the major towns and district, or parish names for rural areas, additionally, special risk locations will be included. Associated with each entry in the gazetteer is a list of nearest pumps and special appliances (PDA) from which the operator can select the most suitable response to the incident.

Increasingly the quality of the gazetteer data is being improved and extended to work with digital maps. In most brigades an extensive map database is held on the mobilising system, this graphical

database providing an alternative method for validating addresses and also a more appropriate means for holding risk and general reference data.

5.4.4 Maps

In Control Centres, Ordnance Survey maps of the mobilising areas are available for reference purposes, giving such information as the boundaries of the area and the location of stations. In addition, larger scale maps may be held, together with plans and diagrams giving details of motorways (with their access and exit points), dock and harbour areas, new city development complexes, unusual special risks, etc. Street maps, often in a book format, are also held to assist with the location of streets and to enable directions to be passed to appliances, officers or other agencies.

As the amount of information available to a brigade and required by the fire fighters grows, almost exponentially, the Control Centre is seen increasingly as the most suitable repository and distributor of this data. It is now an essential requirement that this information can be easily retrieved through the mobilising workstation either for review by control, or for dispatching to a fire station or incident ground.

This has led to the introduction of commercially available computer software to support these functions. Much of this information is held in graphical, or geographical form. Graphical Information Systems (GIS) allow mapping data to be manipulated and presented to the Control Centre operator. The maps can also be linked to the mobilising system so that when a database search matches the address criteria, the correct map showing the address location is displayed to the operator.

These GIS's are able to interact with other software such as word processors and graphical presentation technology so that composite packages of information can be developed. Maps of a Fire Service's area can be presented with facilities to zoom from small scale to large scale presentations. As these maps are composed as a series of layers it is possible to select the level at which certain features are displayed, e.g., text can be displayed only when it is possible to read it. Overlays can be added to give details of hydrants and water mains

Figure 5.6 *Graphical Information System Display.*
(Photo: Bedfordshire and Luton Fire and Rescure Service)

or gas pipe lines or any other features that have a significance to fire service operations.

Using the facilities of word processing and other software, it is possible to display information from the inspection of premises as text, with drawings, photographs, diagrams and even video clips all linked and accessed from the map presentation. As with the resource display, this screen of information may then be displayed at the operator's VDU or projected on to a wall display and, because the data is held electronically, may also be transmitted to other computer systems including those on appliances or special vehicles.

Brigades are able to obtain maps from Ordnance Survey through Service Level Agreements.

5.4.5 Automatic Fire Alarm (AFA) Terminations

The majority of manual AFA terminations were disconnected when Control Centres migrated to computer aided mobilising systems. However, AFA activity can be properly supported by computer technology. Such a system is currently in use by some Fire Services which act as a collector station to commercial premises.

5.4.6 Secondary Control Facilities

Control mobilising systems incorporate a number of levels of resilience. Duplicated computer systems and fallback bearers each add their own levels of security to the system, as does the ability to alert crews locally from the fire station.

These facilities do not, however, cater for the rare possibility of having to evacuate the main control centre. Systems have been developed which permit restoration of basic turn out facilities from other locations.

Different mobilising systems provide different secondary control provisions ranging from a portable laptop computer containing the basic mobilising system and communications interface to a duplicate control on the same site as the main control or at a remote location.

Secondary control facilities should be provided with facilities for the reception of emergency and other incoming and outgoing calls, the despatch of resources and the operation of the main scheme radio at a location that would not be affected by any disruption to services provided at the main control. This may necessitate locating the secondary control with emergency telephone lines from a different exchange to those of the main control.

5.4.7 Control Centre Software

With the advent of mobilising equipment based on PCs and the proliferation of computer systems in the workplace Control Centres now have commercially available software packages for their use. These systems may reside on PCs that are also used for mobilising or on stand alone machines.

These packages generally include:

- Word processors for producing text e.g., aides memoires, help files and specific instructions which can imported into other systems, including the mobilising system.
- Spreadsheets for manipulating data.
- Presentation software to produce lectures.
- Databases to produce statistical analysis and performance indicator criteria - required by the Home Office.
- Graphical information systems to produce maps and analyse statistical data in a mapping format.
- Fire reports (FDR 1 's) - required by the Home Office.

5.5 Equipment at Fire Stations

5.5.1 Mobilising Computer

Some Brigades utilise a computer on each station that acts as a station controller, this controls most of the equipment associated with the mobilising of crews. There are a number of data links to various items of equipment as defined below.

5.5.2 Printers

Printers in fire stations are primarily used for receiving turnout instructions from controls following the operation of the 'turnout' alarm system. They can also be used for the receipt of other non-urgent operational information.

5.5.3 Alerter Base Station

Fire stations with retained crews have a base transmitter to activate the alerters, this equipment is capable of alerting crews with a number of different signals. A positive acknowledgement is transmitted via the data link to the mobilising computer, and onward to the brigade control room when the equipment is actuated.

5.5.4 Public Address System

Many fire stations and headquarters have public address systems of one kind or another, with loudspeakers sited strategically throughout the building. These broadcast routine and domestic announcements.

A number of Brigades now use improved types of remotely controlled public address systems on whole-time stations for alerting crews and the broadcasting of turnout instructions as well as rou-

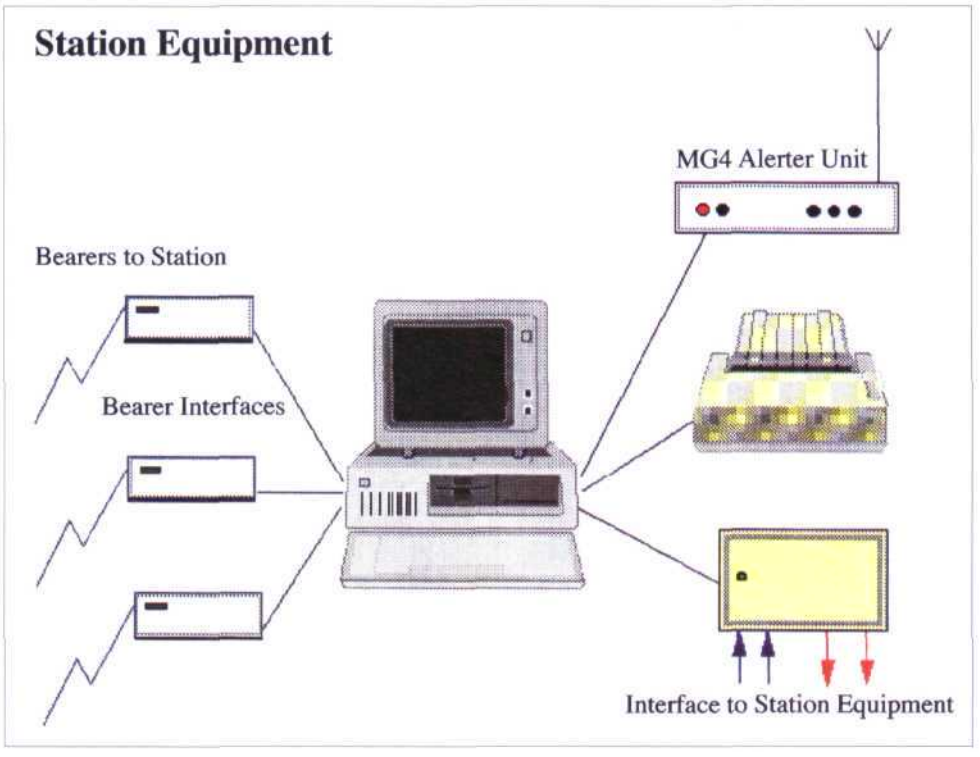

Figure 5.7 Station Equipment.
(Graphic: Fortex

tine announcements. A number of different tones can be sent over the systems that enable crews to distinguish the type of message being broadcast.

Station Bells/Alert Tones

A system of alarm bells/tones, usually referred to as 'turnout bells' has, from time immemorial, been part of the normal equipment of fire stations. It is used primarily for alerting personnel, the turnout instructions being passed by teleprinter or telephone.

On some stations, a simple system of one or more circuits of bells is used for alerting personnel in all parts of the premises.

5.5.5 Turnout Lighting

Fire stations, both those continually staffed and retained, usually have automatic facilities for switching on selected lights to illuminate those parts of the station that are used by personnel responding to calls in the hours of darkness.

These lights are generally controlled via a relay box which, in turn, is connected to the mobilising computer. Following operation they may be on a time switch and stay on for a fixed period of time, or may be reset manually.

5.5.6 Alternative Power Supply

Mobilising equipment should be provided with alternative power facilities for use when the normal power supply fails. The types of system can vary, but in most cases consist of an uninterrupted power supply (UPS) That is a bank of batteries that are continually being charged to supply power in the event of a failure, These are connected to the mobilising computer by a data link and will inform the control room of both the failing of and restoration of normal power.

5.5.7 Exhaust Extraction Systems

A number of brigades utilise exhaust extraction systems to remove exhaust fumes from the appliance bay. These are normally actuated by the turnout system and will remain on for a set period of time. They can also be reset manually.

5.5.8 Control of Traffic Signals

In large towns and cities, provision can sometimes be made for traffic signals in the vicinity of the fire station to be operated by the mobilising computer or from the watchroom, to stop traffic and give fire appliances a clear exit from the station.

5.5.9 Automatic Appliance Room Door

Electrically operated appliance room doors are provided on some fire stations. In addition to having manual controls and built in safeguards, these will be linked so that they can operate concurrently with the station alerting systems.

5.5.10 Running Call Facilities

Some fire stations provide facilities (with instructions on how to use them), to enable members of the public calling personally at the station to summon the brigade. This type of call is known as a 'running call'.

Where there is always someone available in the fire station premises, a switch, usually labelled 'Fire', is sometimes provided on the front of the fire station for use by the public. This actuates an alarm within the station, which alerts personnel for a turnout and summons a firefighter to the front doors to obtain particulars from the caller.

At fire stations where there is not always someone available on the premises, e.g., a day staffed or retained station where all personnel attached to the station turn out on the fire appliances, there is usually a special telephone at the front of the fire station for use by 'running callers'.

This telephone, suitably illuminated and labelled with instructions, may sometimes be an ordinary exchange line with limited dialling facilities to prevent misuse, on which the caller may dial 999/112. It could also be a telephone linked to a private wire communications network which, when the handset is lifted, connects the caller instantly to the appropriate Control Centre.

In all cases instructions should be displayed on how to use 'running call' facilities and include directions as to what the caller should do if the system is out of order or if for any other reason there is no response. If facilities are not provided notices should be displayed informing the caller of the location of the nearest public telephone.

5.5.11 Enquiry Bell

It is common practice for continuously-staffed stations to have an enquiry bell circuit installed, with a press-button labelled 'Enquiries' at the main entrance to the station. Operation of the button actuates a bell or buzzer in the station. The enquiry bell is normally intended for non-urgent enquiries only.

5.5.12 Other Ancillary Equipment

With the introduction of modern systems virtually any piece of equipment can be operated on the actuation of the station alerting systems. Such examples are the switching off of cookers, kettles and other electrical equipment.

Chapter 6 - Automatic Fire Alarm Transmission Systems

The purpose of automatic fire detection equipment is to give early warning of fire. It is essential that automatic fire alarm calls should be transmitted to Fire Service Control Centres as quickly and reliably as possible.

There are many different types of automatic fire detection devices and systems installed within buildings to detect one or more of the characteristic phenomena of fire (heat, smoke or flame) and actuate alarm devices or systems.

Arrangements for linking automatic fire detection systems with a brigade Control Centre or a commercial Central Alarm Station.

The main elements are:

- A means for transmitting signals from the protected premises to a remote manned centre (RMC), such as a Brigade Control Centre or a Central Alarm Station; and, where the RMC is a Central Alarm Station: the processing of signals at the Central Alarm Station.

- A means of communication between the Central Alarm Station and the Brigade Control Centre.

No matter how comprehensive and efficient an automatic fire detection system may be, its task is not fully completed until it has informed those responsible for taking appropriate action that there is a fire in the building. Therefore, if the purpose of the system is to protect property, there will need to be an efficient and reliable method of transmitting fire signals automatically to a remote manned centre unless there is a very reliable means of on-site monitoring e.g., at a permanently manned security gate-house. If the fire detection system is intended to satisfy the fire insurer, this will normally be a requirement.

Such a system will also be required in premises where rapid fire brigade attendance is a pre-requisite of life safety e.g., hospitals, unless the fire alarm system is monitored at all times at a fully manned location.

Where an automatic transmission system is provided, it should transmit a signal to the RMC as soon as the automatic fire alarm system operates. In exceptional circumstances, a time delay unit (TDU) may be provided to permit an investigation prior to the transmission to the RMC. A TDU should, however, only be used if there is a false alarm problem that cannot be addressed by other means. A TDU is not acceptable in hospitals and, in other premises, it should only be provided after consultation with the brigade and the insurer.

The performance of the alarm transmission link may be expressed by the probability of an alarm call being received at the Brigade Control Centre within a specified time. The 'time of transmission' is the period, expressed in seconds, between the start of the transmission of the alarm signal from the premises and the point in time of connection to the fire brigade control. Ideally, this should not exceed 60 seconds.

6.1 Transmission Methods and Reliability Issues

As is always the case, economics is a relevant factor which directly affects system planning and, since highly reliable communication systems cost more than less reliable ones, there are a variety of systems in use throughout the country.

Mention has been made of Fire Alarm Systems (FAS) being connected via remote manned centres (RMC) to local authority fire brigade Control Centres. There are, in a few areas, facilities for

FAS to be connected directly to lire brigade Control Centres, for instance, Merseyside Fire Brigade monitor systems within the Merseyside area.

Devon Fire and Rescue Service collect signals from data transmitters direct into their command and control computer. Two simple key operations will display the PDA to the premises on the operator's screen. Warwickshire Fire and Rescue Service also monitor FAS within Warwickshire (and some outside the county) via a digital communicator.

Several small areas of the country, (Cambridgeshire, Norfolk, Suffolk and Fife) are covered by the 'Alarms By Carrier (ABC)' system. This uses the subscriber's normal exchange line onto which is superimposed an inaudible signal so that the line is continuously monitored, by British Telecom. Fire signals are routed directly to, and monitored at, the brigade Control Centre where the ABC system interfaces with the mobilising system, this enables the alarm signals to be displayed directly onto the mobilising screens.

Other than in a small number of areas, examples of which are contained in the first paragraph above, and in the four counties served by ABC. there are generally no facilities for transmission of fire signals from FAS direct to fire brigade Control Centres (except by 999 autodiallers, the use of which is now discouraged). Signals are normally routed to an alarm company Central Alarm Station.

A British Standard Code of Practice, BS 5979 (Code of Practice for Remote Centres for Alarm Systems) gives recommendations for the planning, construction, facilities and operation of Central Alarm Stations that monitor fire alarm, intruder alarm and/or social alarm systems.

The code recommends that the date and time of origin of all incoming and outgoing signals, and incoming and outgoing communications are automatically recorded.

With regard to communications with the fire brigade, BS 5979 recommends that there be two independent means of outgoing communication between the Central Alarm Station and the Control Centre of the fire brigade appropriate to the geographical area from which alarm signals are received.

This latter caveat is particularly important. **It is unacceptable for a Central Alarm Station to receive connections from FAS in areas for which there was no acceptable means of communication between the Central Alarm Station and the relevant fire brigade.** It has been known for a Central Alarm Station to dial 999 in the hope that the local brigade will connect them to the appropriate brigade.

The use of the fire brigade administrative telephone number for passing fire calls is also unacceptable.

The code recommends that the two means of communication with the fire brigade be selected from the following:

- A dedicated voice transmission path.
- A supervised data transmission path.
- An ex-directory telephone number for the Control Centre **(this should be recognisable at the Control Centre as an emergency call from the Central Alarm Station).**
- The 999 system, provided this will result in the public telecommunications operator routing the call to the appropriate fire brigade (this is clearly only possible if the Central Alarm Station and the protected premises are located within the same fire brigade area).

A single ex-directory telephone number served by two or more lines on a hunting group at the fire brigade Control Centre is regarded as two independent means of communication.

On receipt of a fire alarm signal at the Central Alarm Station, action should be taken by an operator at the Central Alarm Station to establish communications with the appropriate fire brigade Control Centre within:

(a) 30 seconds for 80% of fire alarm signals received; and

(b) 60 seconds for 98.5% of fire alarm signals received.

These times exclude delays in transmission of the signal from the protected premises to the Central Alarm Station, and any delays in answering calls at the fire brigade Control Centre; they represent a form of Central Alarm Station response time.

The Loss Prevention Certification Board (LPCB) operate an approvals scheme for Central Alarm Stations that monitor fire alarm systems. The Central Alarm Stations are approved to the LPCB Loss Prevention Standard LPS 1020: Requirements for Remote Centres for Fire Alarm Systems.

It is a requirement of LPS 1020 that the Central Alarm Station must be able to offer an LPCB approved system for the transmission of fire alarm signals from the protected premises to the Central Alarm Station, although the approved Central Alarm Stations can also offer other methods of transmission that are not approved. Although the LPCB are responsible for the approval scheme, it is operated jointly by the LPCB and its sister organisation NACOSS (The National Approval Council for Security Systems), and inspection of Central Alarm Stations is carried out by NACOSS.

The LPCB publish a list of Central Alarm Stations that have been approved under LPS 1020. This list indicates, for each Central Alarm Station, the geographic areas from which the Central Alarm Station is approved to receive fire alarm signals. This provides confidence to the user that there is third party verification that the Central Alarm Station complies with good practice, that there is an agreement with the relevant fire brigades and that there is suitable means for passing fire calls to them.

CACFOA and the British Fire Protection Systems Association (BFPSA) have developed a Model Agreement relating to AFD systems connected to Brigade Control Centres via commercial Central Alarm Stations. The Model Agreement would be between the Local Fire Authority and the Central Alarm Station.

Brigades should make use of the Home Office/ CACFOA/BFPSA document entitled 'Avoiding Unwanted False Alarms Generated by Automatic Fire Detection Systems', as issued in DCOL 6/96 (in Scotland as DFM 8/1996).

In general, the requirements of LPS 1020 are incorporated within BS 5979. One of these requirements is that LPS 1020 approved Central Alarm Stations must prepare a written report describing the circumstances, and action taken, in all cases where the time between receipt of a signal and transmission of information to the fire brigade exceeds 3 minutes. (This includes any delay in answering the incoming call at the fire brigade Control Centre.)

There are four distinct means for transmitting fire signals from protected premises to RMCs.

These are:

1 Digital Communicators which automatically dial the Central Alarm Station using PSTN, and transmit a coded signal to a receiver at the Central Alarm Station.

2 Private circuits, which provide a permanent monitored transmission path between the protected premises and the Central Alarm Station.

3 British Telecom 'CARE" system, which is similar in principle to ABC, in that it uses the subscriber's normal telephone line to carry alarm signals 'piggy back', but is used to route signals to a Central Alarm Station rather than the fire brigade.

4 'Paknet Radio Access' links a protected promises to a Central Alarm Station using Vodafone's public data network. Connecting an alarm panel to a Paknet Radio-Pad provides access to the network, enabling alarm signals to be sent to the Central Alarm Station.

Prior to the widespread introduction of the digital telephone network, research showed that digital communicators, which are probably the simplest and least expensive form of transmission system, were relatively slow and less reliable that methods involving private circuits. The speed and resilience of the digital telephone network has improved the

speed and should have enhanced the reliability of this method, but no recent research has been published on the subject.

Private circuits may, over relatively short distances, be established on a 'point to point" basis, but over longer distances part of the path between protected premises and the Central Alarm Station is usually shared by many subscribers. In the latter case, the many subscribers are connected via the alarm companies' ' Satellites' (data concentrators), from where a large number of signals are multiplexed via private data circuits. This offers a reliable, fully monitored signal path at, possibly, the highest cost.

British Telecom's CARE system is quite economical because it uses an existing telephone line. Cost is, therefore, independent of distance between the Central Alarm Station and the protected premises. This system is now available in most areas of the country.

Vodafone Data Network provides periodically monitored communications between a protected premise and a Central Alarm Station, using Paknet Radio Access. The cost is the same as a monitored telephone line and is independent of distance between the protected premises and the Central Alarm Station. With radio coverage approaching 95% of the UK population, Vodafone Data Network is increasingly being adopted for alarm communications.

6.2 Social and Community Alarms Centres

Community (social) alarms are found in the homes of over one million people, who are described as, 'vulnerable' in the UK. Most of those people are elderly and/or disabled but there are many other groups including some of those discharged early from hospital. Many of the alarms are located in individual dwellings and are connected to a 24 hour Community Alarm Centre (CAC) via the PSTN telephone.

A call to a CAC can be triggered by pressing the button on a portable pendant or on the telephone. Similar alarms located in sheltered housing schemes for older people are often activated by pulling a cord. During the day most 'Sheltered' alarms are monitored by the resident warden and switched to a CAC when the warden is off duty. Calls can also be triggered remotely by sensors in smoke or intruder alarms, either in individual homes or in communal areas.

When an alarm (which may relate to a range of situations where help is required) is actuated, either remotely or by a resident, an electronic signal is transmitted to the CAC. Detailed information about the caller is automatically displayed on the CAC operator's computer screen.

This information could include vital data on the caller's personal situation including, for example, medical details. Most of the calls received are not emergencies and are usually requests for reassurance or information. In many cases a CAC can respond to a situation by sending out it's own mobile warden service or alerting family, friends or neighbours. However, there will be times when the operator needs to contact an emergency service, including the fire service.

The policy of the national Association of Social and Community Alarm Providers (ASAP) is that, in an emergency, residents should always ring 999 directly as this is the quickest way of contacting the Fire, Police or Ambulance Services.

There are times, however, when a call will be routed via a community alarm centre because:

- many residents in sheltered housing do not have a telephone and their only means of calling for the emergency services is via their community alarm;
- some residents are able to summon help, perhaps by activating their pendant, but may not be capable of talking due to a heart attack, stroke or fall etc. A CAC operator may, knowing the circumstances of the caller, decide to call out an emergency service. **The information which the centre possesses may be vital in ensuring the most effective response from the emergency services;**
- some calls are automatically routed to the CAC by a smoke or intruder alarm;

- some community alarm users are confused and cannot easily communicate with anyone, including the BT operator. The CAC operator is a vital intermediary; and

- some residents, perhaps because of dementia, who have called the CAC do not realise that the situation requires one of the emergency services.

In practice, Community Alarm Centres filter out many calls which might otherwise have led to an unjustified 999 call.

There are approximately 350 CACs in the UK and the emergency services will regularly receive calls from them. CAC operators are in a unique position to help emergency service control staff if a call is routed via a CAC because they:

- are trained and experienced in dealing with emergencies;

- are trained and used to dealing with vulnerable people;

- have detailed information about the person in need of help;

- will have detailed information on the address of the emergency and on emergency access to sheltered housing schemes which can be passed to crews attending the fire;

- can reassure the individual and liaise with them until the brigade arrives; and

- can alert and liaise with other agencies and carers that might need to be involved.

ASAP and CACFOA have agreed procedures for filtering and passing emergency calls from sheltered housing schemes to the fire service.

Should the caller require the fire service one of three procedures will be used:

1 CAC operators will dial 999 for emergency calls to addresses within their own area.

In addition to the name and telephone number of the control centre and the address of the incident, the CAC operator may give a reference number of the housing scheme (for cross reference to the PDA) and any access codes or instructions.

2 Some Community Alarm Centres monitor calls over more than one Fire Service area. These become 'out of area' calls which risk being mis-routed. The procedure for these calls is that the CAC operator will dial 999, give the name of the community alarm centre, ask for the relevant emergency service and instruct the BT operator to disregard the CLI shown.

The BT operator will ask for the CAC client's full telephone number which is then typed onto the BT screen to give the connect-to numbers for the area from which the original call was made. The community alarm operator will then talk to the EA operator and pass details of the call.

This process will add about six seconds to the call but eliminates the risk of 'mis-routes'. **BT operators will monitor for the duration of the call.**

3 Community Alarm Centres should be given details of appropriate ex-directory numbers for instant access to the relevant Emergency Service Control Centre free of charge.

Chapter 7 - Automatic Vehicle Location Systems

Automatic Vehicle Location Systems (AVLS) are not new, they have been used in the United States tor some time and by a number of security firms in this country. More recently Ambulance services have taken advantage of the technology to enhance their vehicle availability and running times.

Around this time many Fire Services were replacing their mobilising and communication systems and revamping or moving into new Control Centres.

During the upgrade many of the large and expensive resource display boards were replaced with screen based resource displays incorporating simple mapping or full Graphical Information Systems (GIS).

As Fire Service personnel became aware of the potential of GIS. it became obvious that questions about AVLS, in relation to the Fire Service, would soon be asked.

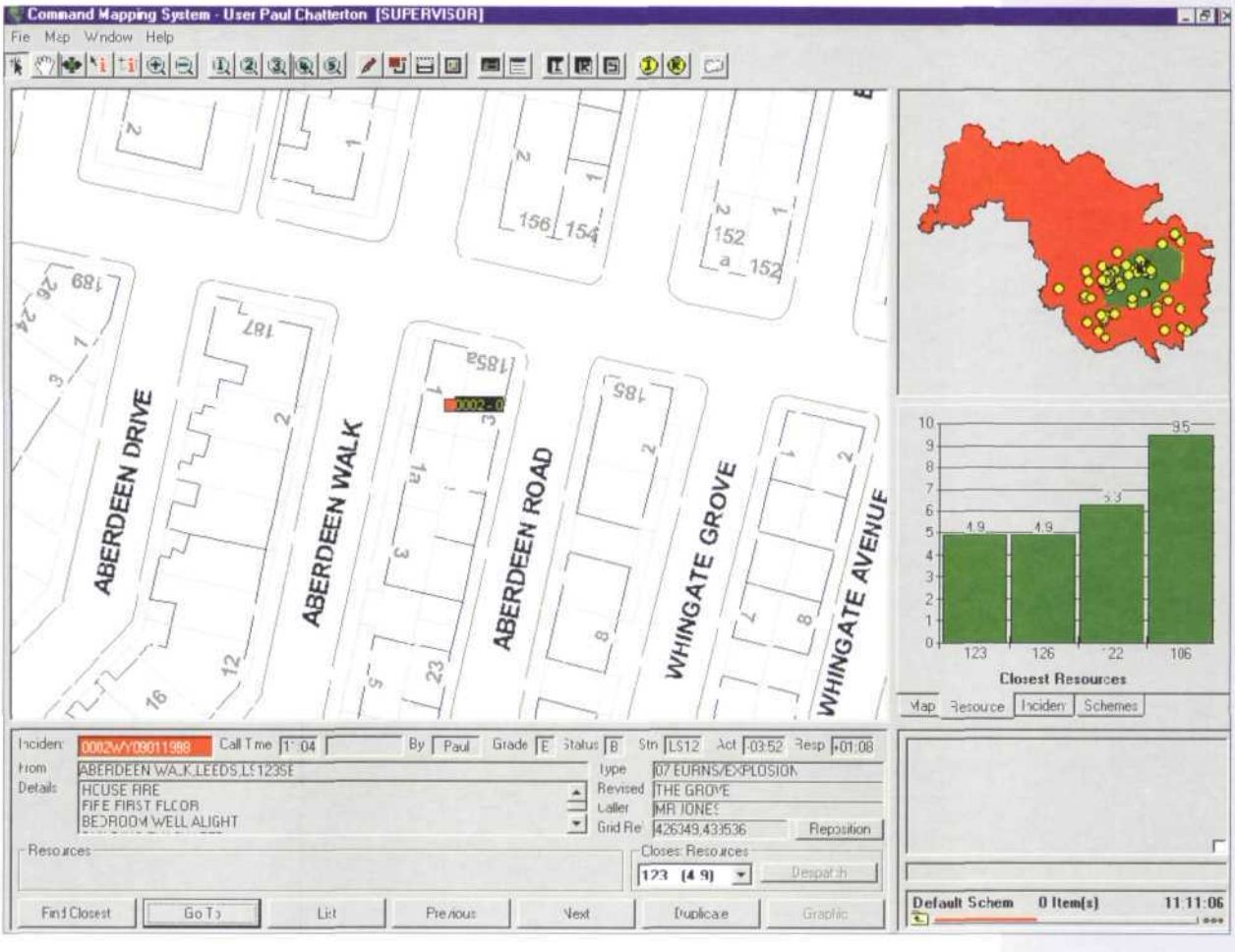

Figure 7.1 An example of a screen format using an A.V.L. system. (Graphic: Fortek)

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HM Fire Service Inspectorate took the initiative, and a consultancy project was set up to **'investigate the applications and possible benefits of Automatic Vehicle Location (AVL) in the U.K. Fire Service'.**

The consultancy contract was awarded to Fortek Computers Ltd by the Fire and Emergency Planning Directorate as part of a Research and Development programme managed by HM Fire Service Inspectorate. The contract was awarded in October 1994 and ran for two years.

The findings of this consultancy were published in DCOL 8/1997 (in Scotland as DFM 8/1997).

7.1 AVLS Technology

An Automatic Vehicle Location System has the capability to report vehicle positions to a central control centre either at regular intervals or on demand, or a combination of both. Several technologies are used world wide although in the U.K. two systems predominate.

Systems based on GPS (Global Positioning System) utilise time signals received from a constellation of 24 satellites moving through precisely defined orbits to calculate the position of GPS receiving equipment located in the vehicle. Timing signals are transmitted by the satellites on an almost continuous basis and hence the vehicle position is always known providing sufficient satellites are in view of the GPS receiver. A minimum of three satellites (ideally four to eliminate certain minor inaccuracies) must be in view of the receiver for it to calculate its position.

A terrestrial based system, as supplied by Securicor Datatrak Ltd, uses a series of low frequency radio base stations to distribute a matrix of radio signals from which a Datatrak receiver can calculate its position using a form of triangulation.

In most places both systems can determine a vehicle's position to better than 100m and frequently better than 50m. There are, however, locations (e.g., built up urban areas) where the accuracy of the positional calculations are compromised by physical or geographical phenomena (e.g., high rise buildings obscuring the satellites from the GPS receiver).

Both systems require a data network to deliver the positional data to the communications centre. The Datatrak system utilises a national radio network set up specifically for AVL reporting. GPS based systems require a mobile data network to be provided. This requirement can be met either by using a public data network or a PMR channel with a data capability.

The final component of the AVL system involves the processing and presentation of the AVL data to support the control room and management task of a fire brigade. While the computation and delivery of a vehicle's position can be achieved through the use of commercially available components, the application of this data to benefit a fire brigade requires a degree of customisation.

Figure 7.2 'Mobile Radio' data terminal. (Photo: Fortek)

Figure 7.3 Securicor Datatrak Ltd data terminal.

Figure 7.4 GPS Antenna mounted in centre of appliance roof.
{Photo: Fortek)

Figure 7.5 Data terminal installed in cab.

Figure 7.6 Mobile Data equipment in appliance under rear seat.
(Photo: Fortek)

7.2 Potential Benefits of AVLS to the Fire Service

Potentially, AVL data can be used to assist in the deployment and mobilising of brigade resources and to improve the quality of data recorded against each incident.

Knowing the precise location of each brigade resource should enable the control room to optimise resource deployment and to ensure that the most appropriate (quickest suitable) resources are despatched to an incident.

Present mobilising policy seeks to achieve this objective by using Pre-Determined Attendance's (PDA's) which are compiled on the basis of appliances being at home station, and, hence, at a known location when they are despatched to an incident, which in a typical brigade will be the case for approximately 80% of incidents.

AVL data, therefore, has the potential to assist in the mobilising of resources to some 20% of incidents by providing accurate positional fixes for the mobile appliances. This information can then be used by the mobilising system to compute the nearest/quickest appliances to the incident.

Generally speaking, the resource deployment strategy used by brigades necessitates standby moves to key stations to cover station areas when appliances from that station area are unavailable. Without AVL, an appliance crew report their position as within a station ground which in many cases is a rather imprecise location.

Through the use of AVLS, a far more precise location is available for each resource and, hence, the opportunity exists to deploy resources to more accurately reflect the needs of the risk areas and their corresponding standards of fire cover.

Until recently the only parameter available for defining location in the preparation of incident statistics and analysis has been station ground. This situation has improved slightly in those brigades where the streets and places gazetteer includes a grid reference which can be filed with the incident log and used in subsequent analysis.

AVL fitted appliances booked in attendance would also be reporting their exact position and, hence, the position of the incident. Further information, such as the position of the appliance when it booked mobile to incident could also be saved for future response time analysis.

7.3 AVL System Implementation

AVL systems have been implemented in many commercial organisations and other emergency services within and outside of the U.K. An investigation into the performance of a number of these systems and the experience gained from the Pilot System installed in Avon Fire Brigade has highlighted features which will compromise the effectiveness of AVL in the Fire Service, the more significant of which are discussed below.

Most fire brigades see the main benefit of an AVL system as being the ability to identify and despatch the nearest/quickest appliances to an incident, regardless of whether they are mobile or not. While theoretically this is possible, current AVL systems have not been designed to meet this requirement and it is not easily achieved.

The difficulties in achieving this principal objective arise from the errors in the data that will be used in the calculation of the nearest appliance list. These errors derive from:

- Inaccuracies in the incident location.
- Inaccuracies in the reported positions of each mobile appliance.
- Inaccuracies in computing, for each appliance, the running time from its present position to the incident location.

As with the existing PDA system the acceptable level of inaccuracy will vary according to risk and the associated standards of fire cover. In areas where parish, or area, mobilising is used, the largest source of error will invariably come from the incident location. In urban and high risk areas where street and premises locations are held in the gazetteer the inaccuracies in the reported vehicle positions will be the more significant.

It should, therefore, be left to the brigade to specify the accuracy required from the AVL system and for the supplier to establish whether such an accuracy can be achieved, and at what cost.

It is difficult to set an expectation of what can be reasonably achieved. However, as a guide, it is reasonable to expect the computed running times in the list of nearest appliances to be accurate to within 90 seconds.

The 'Pilot' System showed that the required functionality can be met if AVL positional updates are transmitted with each resource status update, upon a request from the mobilising system or control centre operator and, periodically, at a rate dependant upon the resource status.

If a public data network is to be used then the interval for periodic updates could be several minutes without seriously compromising the system integrity. However, if updates can be delivered at no cost other than network loading then the interval set should be such that it does not impact upon the other data traffic.

Most mobile data terminals and portable PCs can now be fitted with a GPS transceiver and most transceivers will compute the vehicle position to the level of accuracy required for fire brigade applications. Certain units will perform better than others in difficult areas such as urban areas where satellites may be hidden from view by high buildings. Therefore, **the performance of the proposed GPS transceiver should be checked in various key locations throughout the brigade area.**

The same approach is recommended if a terrestrial solution is being considered.

7.4 Operational Considerations

Present mobilising procedures and PDA's reflect the principle that, if available, an appliance will be despatched to an incident in its own station ground. In the 'Pilot' site, where this policy applies, there were numerous occasions where other appliances, sometimes at home station and sometimes mobile, were calculated to be nearer than the appliance in whose station ground the incident had occurred.

Furthermore, in busy periods it is conceivable that appliances will get drawn across the brigade area, on the basis of being the nearest available appliance in a sequence of incidents, into areas with which they are not familiar and for which they may not carry appropriate information.

With current resource deployment and mobilising policies AVL data will be of relevance for approximately 20% of emergency calls, i.e., when mobile appliances are considered for mobilising.

Through the use of AVL data, it is possible to move appliances to standby points other than fire stations while still being able to identify the nearest appliances to respond to new incidents. Such a policy, operated in a limited form in one brigade, has already shown savings by reducing the need to turn out retained fire stations

7.5 Implementation Costs

The infrastructure requirements (i.e., the need to provide a two-way mobile data network) of a GPS based AVL system are such that it would be wholly uneconomic to consider setting up a system solely for AVL. **For both operational and economic reasons a brigade should consider the introduction of (IPS based AVL only as part of a programme to introduce mobile data.**

If mobile data can be justified in its own right, then the incremental cost of introducing AVL will be relatively small and should definitely be considered.

If the cost of introducing mobile data cannot be justified, then the benefits which could be provided by AVL at relatively minor additional cost, may make the difference in justifying the introduction of the mobile data network.

The terrestrial solution offers a different approach. Since the required infrastructure has already been put in place by Datatrak, it is viable to introduce AVL with relatively little up-front investment. Such a system should provide two-way data which, for mobilising purposes, is considered essential.

7.6 Conclusions

An AVL system operating as part of a two-way mobile data scheme will provide a brigade with the opportunity to simplify, and improve, its mobilising procedures by providing information which can be used in selecting the nearest/quickest appliances to an incident.

Clearly, busier brigades with a high proportion of wholetime crews stand to gain the greater benefits from AVL. However, even these brigades would need to consider changing a number of existing operational procedures.

There would also be a need to make a significant investment in upgrading the data, particularly the gazetteer, used by the mobilising system and possibly to upgrade the mobilising system itself.

Without such a commitment it will not be possible to realise the benefit of improved mobilising.

AVL data will also improve the quality of operational and management information, by accurately locating all incidents, and logging resource journeys to those incidents.

The technology exists to deliver quality data to fire fighters and control staff alike, with AVL data being just one element. In formulating a strategy for the introduction of new technology it is inappropriate to view an AVL system as an independent item, since it will only be effective if it is introduced as part of a broader overall scheme to improve the quality of data brigade wide.

At the time of writing (1998), the incremental cost of including AVL technology as part of a mobile data scheme will be relatively low. However, the investment required to create the environment in which it can be exploited will be significant.

Chapter 8 - Smart and Swipe Cards

Smart Card and Swipe Card systems have been in use both in the commercial and industrial arenas for many years, but have rarely been used for fire service related purposes. Now however, several fire brigades are using them in a number of different applications.

These cards employ a number of tried and tested methods of data capture and transmission, along with associated readers. The reading technology of these cards may be magnetic, bar code, proximity, inductive or 'smart chip'. Data collected remotely is passed via a preferred transfer medium, PSTN. ISDN or radio, etc., to a central point for collation and analysis, and can be integrated by both management information and command and control systems. For example:

(a) In one brigade bar coded swipe cards are used for access control and resource management for retained personnel. These integrated systems have advantages at all management levels and enable control staff to know at any given time, the exact number and associated skills of retained personnel on station. Brigade managers can analyse levels of response, availability of crews and performance of both individuals and stations.

These systems can be used to replace the use of paper methods to record and administer personnel movements that require payment. Swipe card data passed to the Headquarters network makes the automatic payment of fees possible, which is especially useful in relation to retained personnel. Drill and training records can be updated and stored electronically.

Access control eliminates conventional keys and increases security at remote unmanned stations.

The system could be provided in a number of different formats such as bar codes, magnetic strip and contact or proximity smart cards, which would work in the following way:

- Staff members are issued with I.D. cards that can be read by remote station terminals, each card having been programmed by the Central Processor with a level of entry to selected sites.
- At each site an external device controls access via the entry door lock. Members of staff are able, therefore, only to gain entry to sites that have been pre-programmed through the Central database to allow their access.
- bach site also has an internal data terminal through which all persons entering are required to swipe their card. The data relating to entry and exist is transmitted (either in real time or batched) to the Central Processor Unit (CPU) for analysis. This terminal, in effect, logs personnel as 'in attendance' at that station, where they will remain until logging out.
- External and internal card readers at a site are linked and the CPU will be aware of someone gaining access to the site without logging in.
- Appliances, officers, stand-by crews and ancillary staff that require access to stations at any time are issued with an 'all stations' entry card. All attendees are required to log out thus giving accurate timing of retained crews for payment purposes.

Each terminal is fully configurable from the CPU, which means that after installation and commissioning only maintenance visits should be necessary by the supplier. If a card is lost or damaged it

can be rendered void removing any risk of access **by** the finder.

(b) Another brigade uses 'bar-coding' in a different way: Each member of the Brigade, including the Chief Fire Officer and Control Staff, are issued with their own personal tally and bar code. At the change of each tour of duty, the firefighters insert their tallies onto the nominal roll board of the appliance they are crewing. The nominal roll board of the appliance also has a bar code detailing station, call sign and appliance type.

In the event of a large incident, the Incident Command Unit is mobilised and all appliance and personnel tallies are handed in to the Unit. Each bar code is then 'swiped' by an infra red 'pen' to store the information on a personal computer (PC)

The bar code contains the following information:

- Name, rank, station and watch.
- Medical details - blood group, allergies, tetanus injections, etc.
- Exposure to toxic substances.
- Qualifications - LGV, BA wearer, etc.
- Other skills which may include - foreign languages, plumber, electrician, etc.
- Officer's car registration number.

At any point during the incident, the PC is able to provide a printout of all personnel in attendance on the Fireground. This information could be used in the event of an evacuation. It could also be used to determine relief crews and provide information to personnel in attendance should there be a chemical incident with potential long term effects.

Fire Service requirements are fairly basic at present, but full integration with other, available computer systems could provide an effective management tool.

Chapter 9 - CCTV in the Fire Service

Most Fire Service staff will be familiar with the type of Closed Circuit Television (CCTV) used for monitoring premises for security purposes, either in shops, car parks or used to survey headquarters, remote fire stations or even Control Centres — especially at night!

Some years ago the Fire Service recognised the benefits of capitalising on the technical developments of video cameras, and their ability to transmit images by a variety of means, having the potential to provide the Service with new tools to improve the efficiency of rescue and assist with the command role at incidents. These objectives, as well as the secondary, but important, benefits of improving debriefs, identifying training needs and informing the public accurately, led them to explore ways of using this equipment effectively on the fireground.

Because firefighters need to know as much as possible about the emergencies and the dangers they may be facing, the best substitute for seeing something directly is to have real time video of the same thing.

Visual information of this kind does not add to information overload in the way that manuals, plans and procedural documents do. Irrespective of whether the incident involves a collapsed building with casualties, a dog lost in a warren or a huge fire that can only seen from one side, there are benefits in providing vision using available technology which would otherwise be difficult, dangerous or impossible to obtain. The use of video equipment allows Fire Service personnel to achieve this.

Information may need to be relayed to a Strategic, Tactical or Functional Command, or the Control Centre. Without doubt. Officers want good quality information about major incidents for debrief, training, enquiries and public relations. Cameras can be provided in small robust units, and the transmission and recording methods available adapted to meet fire service needs.

A number of brigades have been awarded test and development licences by the Home Office to assess the operational potential to transmit audio and visual colour pictures within an incident environment.

Microwave spectrum is used because a wide bandwidth is required to transmit moving colour images.

For example, one brigade concentrated on getting visual information from confined spaces, such as collapsed buildings or sewers, and used video to improve effectiveness of command at major incidents.

Another brigade uses two separate systems which enhance their CCTV applications, one has a Microwave transmitter/Camera, and the other is a Cellsend System. A Bodyworn Microwave transmitter/Camera System is also used.

These systems are described **below.**

The Modular Remote Control Rapid Deployment Camera System - MAVIS, is a remote controlled camera sending high quality vision and sound to a control unit operating either in the ICLJ or, being fully portable, from a forward point or any remote location.

The CCTV system consists of tripod mounted colour cameras, a maglight camera, bodyworn camera and ISG thermal imaging camera as well as a remote control decoder/microwave transmitter and a control case. The control case is mounted in the ICLJ video rack to receive and process the

Figure 9.1 Detail showing camera mounting position. The transmitter can just be seen under the rim of the helmet. The camera sees approximately half the normal field of normal vision.
(Photo : BedfordshireFire and Rescue Service)

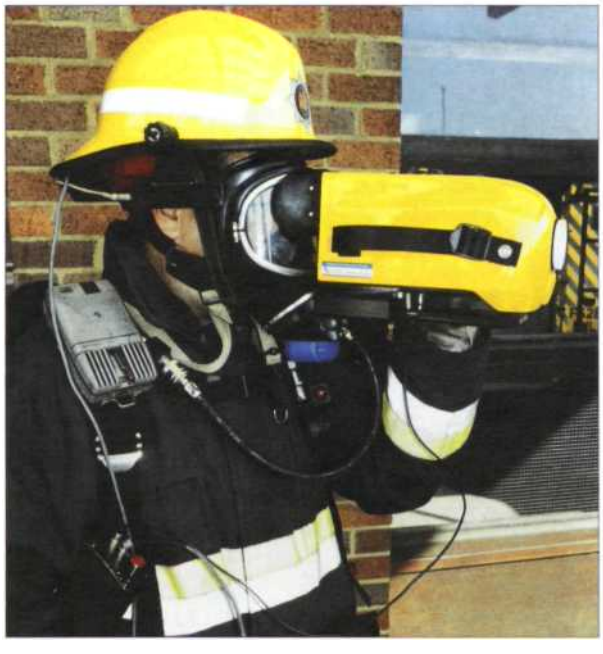


Figure 9.2 BA wearer equipped with high definition helmet mounted colour camera. The combined battery pack and control module {mounted on the waistbelt) permits changeover to thermal images from the TIC. The microwave antenna and transmitter are mounted on the helmet to ensure both protection and height for better image transmission. (Photo . Bedfordshire fire and Rescue Service)

Figure 9.3 One of the original tripod mounted hard wired cameras. These cameras are high definition colour but do not have a zoom facility. Both new and not so new technology work well together.
(Photo:BedfordshireFireandRescurService

signals from the microwave cameras. It can operate independently of the ICU.

The bodyworn high resolution colour camera (about 50cm long and lcm square) is mounted under the right rim of a helmet A microwave transmitter is mounted under the rear rim of the helmet. This transmitter takes its power from a harness mounted battery pack, the antenna is also mounted on the rear rim protruding upwards.

The harness also has a lapel viewer in the form of a small LCD screen which allows the wearer to monitor the video picture being transmitted.

The camera is wired to the transmitter through a connector to allow connection of the ISG thermal/video overlay camera if necessary.

The 'Cellsend' system uses digital technology to send video images from the ICU to the Control Centre.

Two modems are installed, one in the ICU and the other in the Control Centre. The modem in the ICU

Figure 9.4 Video rack installed in an Incident Command Unit. At the top are the quad and master monitors. Below this is the real/lapse time video recorder. Below this is the Cellsend modem that permits transmission of pictures to Brigade Control via GSM telephone. Below this is the video processor for manipulating up to 8 inputs, freezing images and electronically enlarging if required. Other facilities are also available. The unit below this controls the mast mounted camera. The bottom (lighter) unit is the control case for MAVIS and the receiver for the microwave transmissions from both MAVIS and the helmet camera which normally operates within the ICU.

(Photo : Bedfordshire Fire and Rescue Service)

is linked to a mobile GSM phone, while the other is linked to an extension of the Meridian telephone system. The GSM link can be established from either end.

Control Centre Operators can choose the resolution best suited to the image. In high resolution the image is updated a few seconds behind real time, at the lower resolution the image is updated more slowly but technology will continue to improve these times. This update rate is achieved by only updating those parts of the picture that move and the images can be recorded at both ends, it is also possible to incorporate an audio facility. 'Cellsend' does not require a PC to operate the system.

Results from tests in these Brigades indicated the technology worthy of further research.

The general public are more aware of the Fire Service than they were in the past. Unusual incidents are of widespread interest, especially where rescue is involved and these pictures are in heavy demand from news media.

The opportunities provided by developments in communications, computing and video technology enable the Fire Service to provide a more effective, efficient and safe front line service.

Chapter 10

Chapter 10 - Radio

Figure 10.1 Appliance radio in use.
(Photo: HM Fire Service inspectorate)

The Manual of Firemanship first contained, in 1954, a section dealing with Radio. At that time, the majority of fire brigades shared the radio scheme (system) used by the local police force. The situation now is completely different; for many years every fire brigade has had its own radio scheme with a high percentage of fire appliances and other vehicles, equipped with modern 'transceivers' (radio sets capable of transmitting and receiving).

In addition to the standard radio sets fitted in vehicles which communicate primarily with the Brigade Control Room, there is specialised vehicle radio equipment which can communicate with personal radio sets. These provide on-the-spot fireground communications and can have the added facility of being able to link personal radio sets into the main brigade radio scheme.

The primary objective of this book is to provide a basic knowledge of how radio schemes work, their capabilities and their limitations, sufficient to enable Fire Service personnel to get the best possible use from what is a highly sophisticated technical resource.

There is a continuous demand for improvements and expansion to radio schemes; for additional radio 'channels', which permit appliances at different incidents to be dealt with independently; and for new facilities of various kinds. Unfortunately, the unlimited expansion of radio as a medium of communication is not possible. It is a finite resource with clear limits and, as a result, the extent and purposes for which radio may be used are strictly controlled.

The Radio Frequency and Communications Planning Unit (RFCPU) undertakes the setting of communications standards and deals with medium and long term planning needs to ensure that the best possible communications are provided, taking into account the rapidly changing technology to which radio communications, in particular, are prone. Such work includes next generation systems for Emergency Service use, speech and data security, trunking radio schemes, satellites, replacement alerter system planning/evaluation, mobile data, underground radio and line communication.

10.1 Frequency Spectrum characteristics, selection and allocation

10.1.1 The Frequency Spectrum

Radio signals travel through space as a 'wave' which, for the purpose of this explanation, can be likened to a wave on the surface of water. Every such wave consists of alternative crests and troughs to which the following terms apply:

CYCLE - the portion of the wave between successive crests or troughs, which is repeated over and over again to form the continuous wave.

WAVELENGTH - the distance between successive crests, or successive troughs.

FREQUENCY - the number of cycles of wavelengths, which appear to pass a given point in a specified time, usually one second. Wavelength, frequency and velocity are related in a very simple way:

$$\text{Velocity} = \text{Frequency} \times \text{Wavelength}.$$

However, this formula does not show the relationship very clearly. Normally the velocity is a constant for a particular type of wave in given conditions so more specifically:

$$\text{Frequency} = \frac{\text{Velocity (constant)}}{\text{Wavelength}}$$

or,

$$\text{Wavelength} = \frac{\text{Velocity (constant)}}{\text{Frequency}}$$

Radio waves are just one form of what is known as 'electromagnetic radiation', other forms being 'micro-waves', infra-red (heat), visible light, ultra-violet and X-rays.

These all have one very important common characteristic which is that they all travel through space with the same very high velocity. This is 300 million metres, or 186,000 miles per second. For all earthly distances this is virtually instantaneously.

The only difference between the various forms of electromagnetic radiation is that they each occupy different ranges of frequency and, hence, different ranges of wavelengths. Radio waves occupy the lowest range of frequencies (and, hence, the longest range of wavelengths) followed by infra-red, visible light, ultra-violet, and X-rays. Even though they occupy the lowest part of the spectrum, the frequencies of radio waves are quite high in numerical terms. The lowest usable frequency for radio communication is about 10,000 Hertz, corresponding to a wavelength of 30,000 metres.

The highest frequency currently in use for radio communication within the fire service is about 2,300,000,000 Hertz, corresponding to a wavelength of 0.13 metre (13 cms). The Police use higher frequency bands up to 50 GHz for very short (5 kms) links.

1000 Hertz (Hz) is called 1 kiloHertz (kHz)
10,000 Hz = 10 kHz
1000 kHz = 1 MegaHertz (MHz)
1000 MHz = 1 GigaHertz (GHz)

Thus 2,000,000,000 Hertz is more compactly called either 2000 MHz or 2 GHz.

The following are two worked examples using the above formulae:

If a transmission has a wavelength of 4 metres, what is the frequency?

$$\text{Frequency} = \frac{\text{Velocity (constant)}}{\text{Wavelength}} \text{ Hertz}$$

where

Velocity 300,000,000 metres per second
Wavelength 4 metres

Thus

$$\text{Frequency} = \frac{300{,}000{,}000}{4} = 75{,}000{,}000 \text{ Hz or } 75 \text{ MHz}$$

If a transmission has a frequency of 450 MHz, which is a similar frequency to the Fireground channels, what is the wavelength?

$$\text{Wavelength} = \frac{\text{Velocity (constant)}}{\text{Frequency}}$$

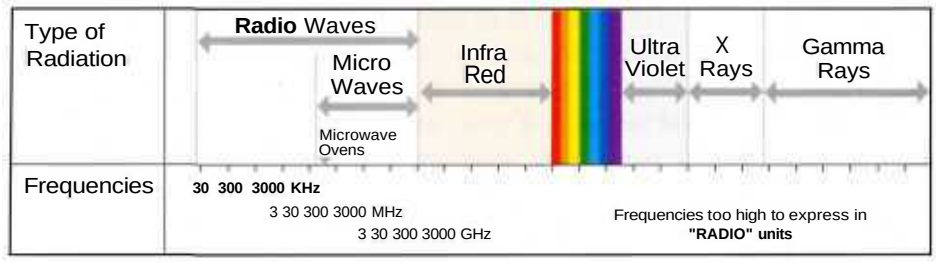
where

Velocity 300,000,000 metres per second
Frequency 450 MHz or 450,000,000 Hz

Thus

$$\text{Wavelength} = \frac{300{,}000{,}000}{450{,}000{,}000} \text{ metres} = 0.88 \text{ metres}$$

Figure 10.2 The electro-magnetic spectrum



The result is that the higher the frequency the shorter the wavelength. For radio waves, 'wavelength' is measured in 'metres' and 'frequency' is measured in 'Cycles per second' for which a special name 'Hertz' is used.

Figure 10.2 shows how the various forms of electro-magnetic wave occupy different parts of the range of frequencies which are known as the 'electro-magnetic spectrum'. With the exception of visible light the boundaries of the various forms are not sharp and there is considerable overlap.

Our interest is with the radio wave portion, extending slightly into the micro-wave portion, and that is expanded in Figure 10.3 with the corresponding wavelengths added.

Radio waves occupy a wide range of frequencies with the maximum being several million times larger than the minimum. This contrasts with the very narrow range occupied by visible light in which the maximum is only about twice the minimum.

The result is that, whereas the various colour components of white light normally all behave in the same way, the lowest range of radio frequencies, e.g., below 100 kHz, will behave quite differently from the highest range, e.g., above 1 GHz. This leads to the 'radio frequency spectrum' being divided into relatively small frequency bands, within each of which all frequencies behave in much the same way and are therefore, suited to a particular purpose. Since every frequency has a unique corresponding wavelength the different frequency bands correspond to different 'wavebands'.

10.1.2 Characteristics of the different Frequency Bands

Figure 10.3 shows, in very broad terms, how the different frequency bands (wavebands) differ with particular reference to the way they travel through space - their 'propagation characteristics', the size of the aerials and the power required.

Frequencies	KHz 30 100 300 1000 3000 KHz	MHz 1 3 10 30 100 300 1000 3000	GHz 1 3 10 30			
Band Names	Low Frequencies Long Waves (LW)	Medium Frequencies Medium Waves (MW)	High Frequencies Short Waves (SW)	Very High Frequencies Short Waves (VSW)	Ultra High Frequencies (UHF)	Super High Frequencies (SHF)
Wavelength (metres)	1000 3000 1000 300 100 30 10 3 1 0.03 0.1 0.03 0.01	CMS 100 30 10 3 1cm				

Figure 10.3 Divisions of the radio spectrum

Consider the size of the aerial. It is common knowledge that, for receiving, the size of the aerial is not very important, indeed the vast majority of transistor radio receivers operate very well with no visible aerial at all. The aerial is a coil wound round a magnetic rod (ferrite aerial). However, for transmitters the position is totally different; for effective transmission an external aerial is essential and its length must be carefully matched to the wavelength being transmitted. For the type of aerial fitted on vehicles the correct length is almost precisely one-quarter of the wavelength; e.g., at 30 MHz, wavelength 10 metres, this would be 2.5 metres. For higher frequencies it is shorter, but for lower frequencies it is longer.

From that, and Figure 10.3, it can be seen that, currently, only two parts of the radio frequency spectrum are suitable for land-based, mobile and personal radio schemes: the VHF and UHF parts. Unfortunately these parts are also eminently suitable for many other uses, notably the entertainment side, i.e., broadcast radio and television.

There are also allocations to marine, aeronautical, armed services, public utilities, and other commercial user requirements. There is, therefore, only a limited allocation available to the emergency services, of which the Fire Service is only one.

10.1.3 Frequency Selection and Allocation

From the spectrum characteristics in Figure 10.4 it is clear that the allocation of radio frequencies is not a matter which can be handled in isolation by any one service, by any one government department, or even by any one country. Agreement has to be reached on an international basis as to how the different parts of the spectrum are to be shared between the different types of service for which they are best suited. For broadcasting, civil aviation and the mercantile marine, operation in the same bands of frequencies may be either by regional cover or world-wide.

Block allocations of frequencies, by function, are agreed from time to time at conferences of the International Telecommunications Union, of which practically all countries are members. These block allocations by broad function are then divided nationally among the various users of each type of service.

Low Frequencies (LF) **or Long Waves** (LW)
30 - 300 kHz 10,000 - 1000 metres

Follow earth's curvature. Not screened by mountains etc. Consistent long range both by day and by night. Requires very high transmitter powers and very big aerials. The top end of the band is widely used for broadcasting.

Medium Frequencies (MF) **or Medium Waves** (MW)
300 - 3000 kHz 1000 - 100 metres

Longer ranges by night than by day. Rapidly varying effects at sunrise and sunset. Requires high transmitter powers and big aerials. Widely used for broadcasting, Ship-shore radio, marine navigational aids, etc.

High Frequencies (HF) **or Short Waves** (SW)
3-30 MHz 100-10 metres

Short range over ground, but reflection from upper atmosphere gives very long range both by day and by night with very little power. Vulnerable to atmospheric disturbances, sunspots, etc. Frequency changes needed every few hours to maintain continuous communication. Widely used for long range communication.

Very High Frequencies (VHF) or Very Short Waves
30 - 300 MHz 10-1 metre

Screening and reflection by hills, large buildings, etc., becomes noticeable, gradually approaching visible light characteristics giving significance to line-of-sight. Generally short range over ground, 20 miles (30 km) average, almost wholly dependent on upon line-of-sight, i.e., height of aerial. Fairly constant results both by day and by night but vulnerable to long-range interference during abnormal weather conditions. Ideal for two-way land mobile schemes due to relatively short aerials and moderate power requirements.

Ultra High Frequencies (UHF) or Ultra Short Waves
300 - 3000 MHz 1 - 0.1 metre

Broadly similar to VHF but closer still to visible light characteristics. Screening and reflection more noticeable, but less long-range interference. Shorter range over ground, but line-of-sight even more significant. Lower part of the band is ideal for two-way, hand-held personal radio schemes due to very short, but efficient aerials and low power requirements.

Figure 10.4 Characteristics of different frequency bands

In the United Kingdom, control of the frequency spectrum is vested in an inter-departmental committee comprising representatives of all Government departments with responsibility for frequency-using services. These include the Radiocommunications Agency of the Department of Trade and Industry, the Home Office and the Ministry of Defence. (See **the section on Regulatory Issues.)**

10.1.4 Channel Spacing

It is not possible to convey information by using just a single frequency. A narrow band of frequencies is required which is known as a 'Channel'. Different channel widths are required for different services: for example, a television video channel must be many times wider than a speech channel. Channels are normally known by their centre frequencies and the centre frequencies of adjacent channels must be separated by at least the required channel width in order that there shall be no overlap which would result in unacceptable interference.

In fact the centre frequency spacing of adjacent channels are slightly greater than the 'bandwidths' occupied. Several technical factors, including the design, build standard and achievable frequency stability all determine allowable channel spacing. Technical advances have made it practicable to reduce channel spacing progressively from 50 kHz to 25 kHz and, currently, to 12.5 kHz. Reduction of the channel spacing specification to which all users and, hence, all manufacturers must comply has the effect of increasing the number of channels which can be made available within a given frequency bandwidth. A 100 kHz allocation will take two 50 kHz channels or eight 12.5 kHz channels. This is shown in Figure 10.5.

Nevertheless, there are still not nearly enough radio channels available to meet the growing demands from would-be mobile and personal radio users. Further reductions in channel widths and channel spacing will inevitably be sought as technology continues to improve. The alternative, using digital technology, is to place multiple speech channels onto one radio carrier by giving each one a time slot. The TETRA system which is proposed for the Public Safety Radio Communications Project (PSRCP) has four speech channels in a 25 kHz bandwidth channel, whereas GSM, which is the system used for digital cellular radio, currently has 8 speech channels in a 200 kHz bandwidth channel. Advances in technology will soon increase this to 16 speech channels in a 200 kHz bandwidth channel.

10.2 Radio Scheme Engineering

10.2.1 Modulation methods

The technique of super-imposing a speech signal on a radio wave is called 'MODULATION'. The radio wave then becomes the 'carrier' for the speech and it is often referred to as the 'carrier wave', or simply, the 'carrier'. Basically the radio wave is a single frequency of constant 'amplitude' which means that all the peaks in the wave have the same height and all the troughs have the same depth.

Figure 10.5 Channel spacing.

Modulation can be superimposed by varying either the frequency or the amplitude of the basic radio carrier. Thus, there are two techniques currently in use in the fire service:

(1) Frequency Modulation (FM)

(2) Amplitude Modulation (AM)

Whichever method of modulation is used, the result is to produce 'side frequencies' just below and above the carrier frequency. It is the presence of these side frequencies which causes the radio signal to require a small band of frequencies, and they determine the 'bandwidth' of the signal.

Within the narrow channels used for mobile radio (12.5 kHz) there is little difference between AM and FM in terms of 'user-noticeable' performance. In schemes originally provided by the Home Office prior to 1989, the main and mobile transmitters use amplitude modulation (AM). Whereas in schemes provided and maintained by commercial suppliers they may use both AM and FM depending upon a brigade's stated need to communicate with any adjacent AM brigades.

Simplex and Duplex

The two terms can be taken as a pair. Within the context of emergency services' radio, 'simplex' working is that, while transmitting (sending), it is not possible to receive, so the person receiving cannot interrupt. Any attempt to do so means neither person hears anything. A vital part of 'simplex' operating procedure is the use of the word 'over'. The speaker must say the word before switching from 'transmit' to 'receive', and the listener must hear the word before switching from 'receive' to 'transmit'.

All equipment normally rests in the 'receive' mode, and operation of a 'press-to-speak' key, sometimes known as a 'pressel switch', switches the equipment from 'receive' to 'send'. The key or switch must be released before transmissions from other stations can be received.

'Simplex' working makes it impossible to speak and listen simultaneously, but it has the advantages of encouraging a concise and efficient operating procedure and an economy in the use of words, and of discouraging lengthy conversations. Further, the equipment required is simpler than that needed for 'duplex' working.

Single-frequency

Single frequency radio equipment is designed to transmit and receive on the same frequency. Clearly such equipment can only operate in the 'simplex' mode and, in such equipment, the receiving portion is always effectively switched off when the transmitter is activated.

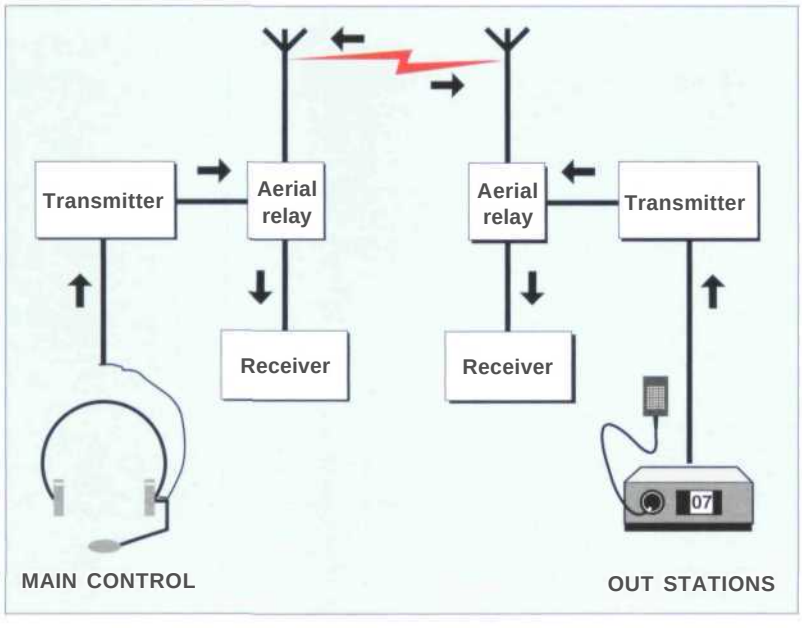


Figure 10.6 Principles of single frequency simplex working.

Single frequency working is not used in main VHF radio schemes between brigade control rooms and mobiles, but single frequency personal radio equipment is commonly used by fire brigades for direct person-to-person working over short distances both with VHF and UHF. (Figure 10.6)

Home Office supplied VHF vehicle-fitted radios are capable of operating on the two VHF channels allocated to manpack working.

Double-frequency or two-frequency

Double or two-frequency equipment is radio equipment which is designed to receive on one frequency and transmit on another and **all** fire brigade main radio schemes operate on this principle (Figure 10.7). The need to occupy two channels of the limited available spectrum is a disadvantage but that is outweighed by the advantages it affords.

'Two-frequency' working permits 'duplex' operation but, in practice, all fire brigade mobiles are 'two-frequency simplex', mainly because of the advantages of 'simplex' already given.

The advantages of 'two-frequency' working are that it permits the control station to operate in the 'duplex' mode, which in turn allows a mobile to 'break-in' to a control station transmission when urgent attention is required due to a priority message. It also permits the engineering of multi-station, wide area coverage schemes.

10.2.2 Talk-through

An important difference between 'single frequency' working and 'two-frequency' working is that 'single-frequency' provides an 'all-hear-all' system, whereas 'two-frequency' does not. In 'two-frequency' working, all the mobiles can hear control, and control can hear all the mobiles, but the mobiles cannot normally hear each other.

A pip-tone 'busy' signal (short 'beeps' about one second apart) is, therefore, transmitted by control whenever it is receiving from a mobile. It is an important aspect of radio scheme discipline that no mobile transmits when the 'pips' are on except in urgent, high priority circumstances.

Although the mobiles in a 'two-frequency' system cannot normally hear each other, there are occasions when it is more convenient for them to communicate directly rather than requiring the control operator to relay a message. To make this possible, 'two-frequency' systems are provided with a facility known as **talk-through.** 'Talk-through' is selected by the control operator and, when it is selected, the incoming speech from any mobile is 'turned round' and re-transmitted. It is, therefore, received by all other mobiles in exactly the same way as speech from the control operator.

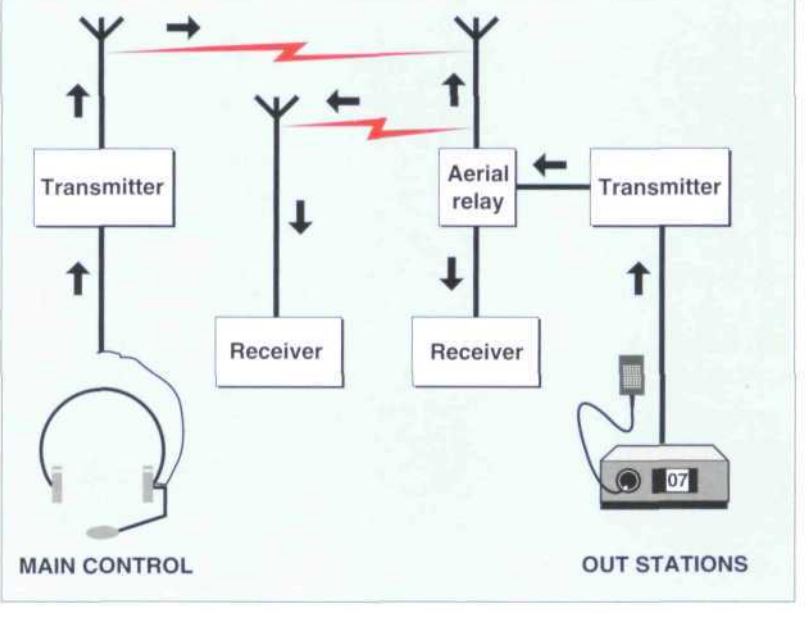


Figure 10.7 Simplex working - out stations only (double frequency).

The control operator can, of course, still hear all the mobile transmissions, and retains full control of the scheme. When 'talk-through' is selected, 'pip-tone' is automatically inhibited, either completely or whenever speech is received from a mobile, and there may be an increase in the level of background noise and some degradation of speech quality, which may be noticed because of the link-up between the incoming and outgoing channels.

'Two-frequency' working provides a measure of security because unauthorised listeners can only hear one way, normally the 'outgoing' transmissions from control to mobiles. However, in fire brigade communications security is a lower priority than speed and it is usually more important for two mobiles to talk to one another. 'Talk-through' provides that speed, and some fire brigades choose to operate their schemes permanently on 'talk-through'.

10.2.3 Wide Area Coverage

This implies that radio communication is required over an area greater than that which can be served by a single base station, no matter how favourable its location may be. All county fire brigade radio schemes fall into this category with the result that at least two, and in some cases more, base stations are required. Hence they are known as **'multi-station schemes'.**

One approach would be for the individual main stations (hill-top sites) to operate on different channels, in other words a number of single station systems, and not an integrated scheme. However, mobiles receiving from one main station would not benefit from the 'fill-in' effects of other main stations as they moved into difficult areas.

The system adopted must **appear** to be a single station system even though two or more stations are involved. It might be thought easy to set all the main transmitters at all the hill-top sites on exactly the same frequency, so that their signals merge into one in the mobile receivers but it is, in practice, virtually impossible.

10.2.4 The Spaced Carrier System

The original, classic solution to the problem was to deliberately off-set the frequencies of the main transmitters within the allocated channel width. The 25kHz channel spacings used at the time permitted at lest three slightly off-set main transmitter frequencies, which a mobile would receive as a single integrated signal without any noticeable interaction.

However, with the compulsion to reduce channel spacing to 12.5 kHz, the spaced carrier system has had to be abandoned because the narrower channel width channel does not permit sufficiently large offsets to prevent noticeable interaction.

10.2.5 The 'Quasi-Synchronous' or 'Common Frequency' System

Fortunately, technical advances have improved the stability of the frequency generators used for scheme main transmitters to the stage where they can maintain an almost constant frequency over long periods of time in spite of changing temperatures, etc. The main transmitters at different sites are not exactly synchronous, but they are almost or **'Quasi' synchronous.**

For all practical purposes they all have the same, common frequency.

As an example, fire brigade scheme main transmitters currently operate at about 70 Mhz. The stability of the 'quasi-synchronous' frequency generators is such that the individual main transmitters in a scheme keep to within less than 0.5 cycle per second of each other.

In conjunction with the method of modulation used, a scheme can be described as 'quasi-synchronous amplitude modulation' or 'quasi-synchronous frequency modulation', with the alternative term 'common frequency' in place of 'quasi-synchronous'.

Doppler Effect

An effect which may be apparent in 'quasi-synchronous' (common frequency) systems, which was never apparent in spaced carrier systems is the 'Doppler' effect. This is the effect where there is an apparent change of frequency whenever there is relative motion between a transmitter and receiver.

If the vehicle is moving towards a fixed transmitter the frequency appears to increase slightly, but if the vehicle is moving away the frequency appears to decrease slightly.

'Doppler' effect is of no consequence in a single station scheme because the change is so small compared with the channel width. Likewise, it was unnoticeable in spaced carrier systems because the changes are so small compared with the deliberate off-sets. However, Doppler effect may well be noticeable in quasi-synchronous (common frequency) systems when a mobile is in an area where it receives more or less equal signal strengths from two hill-top sites and is travelling towards one but away from the other. One frequency appears to increase while the other appears to decrease with the result that the difference super-imposes a 'warble' or flutter on the received speech which varies with vehicle speed.

Every effort is made to engineer schemes, by location of hill-top sites, by adjustment of transmitter power, by use of directional transmitter aerials, etc., so as to minimise the effects, but because its cause is a natural phenomenon it can never be completely avoided.

When a mobile is stationary in a position where it receives more or less equal signals from two stations, the small difference between the two frequencies may be noticeable as a slow 'whooshing'. Normally it is only noticeable when the transmitter is on without any speech and it does not impair speech intelligibility. If it is intrusive, a small change of position, to take advantage of local screening from one station, can be advantageous.

10.2.6 Scheme Engineering

A number of carefully sited main stations (hill-top sites) are required to give brigade-wide radio communication coverage. Figure 10.8 illustrates the way in which such schemes are engineered. There are a number of variations, particularly as far as the linking arrangements are concerned.

Under 'two-frequency working' there are two main frequencies:

(1) **Outgoing** - main station transmit and mobile receive.

(2) **Incoming** - mobile transmit and main station receive. These main frequencies use aerials at, or near, the tops of the masts, and the aerials are almost always omni-directional to cover the largest possible area.

10.2.7 Links

The links between the control station and the main radio stations can be by land line but the majority use radio links (see Figure 10.8). Each radio link has its own dedicated pair of frequencies so that there is no mutual interference. Directional aerials are used - commonly known as 'yagis' - similar, apart from size, to TV or FM sound broadcast aerials. These aerials 'look at each other' from opposite ends of the link to 'beam' the signals and provide the 'point-to-point' mode.

Although, in general, each link has its own transmitter and receiver and its own pair of dedicated frequencies, the outgoing links from control are identical. Channels can be saved and made otherwise available if a single outgoing link transmitter is used and its output is split between two or more aerials, each pointing at a main station. There is then only one outgoing link frequency but, there must always be independent incoming link frequencies and link equipment.

At each main station, the link transmitters and receivers are interfaced with the main transmitters so that, for example, a signal from control is:

(1) Transmitted by the link transmitter at the control station.
(2) Received by the link receivers at all the main stations.
(3) Re-transmitted by all the main transmitters.
(4) Received by the mobile receivers.

A similar sequence, in the opposite direction, occurs when a mobile transmits to control.

In general the above descriptions refer to the use of VHF High-Band linking. Some brigades also deploy onward linking at UHF. However, in recent years there has been a move towards vacating both

VHF and UHF linking in favour of microwave, or land line links. RFCPU have issued policy statements addressing this subject (see section on Microwave).

10.2.8 Frequencies

It is of interest to add up the number of frequencies which are permanently needed in multi-station.

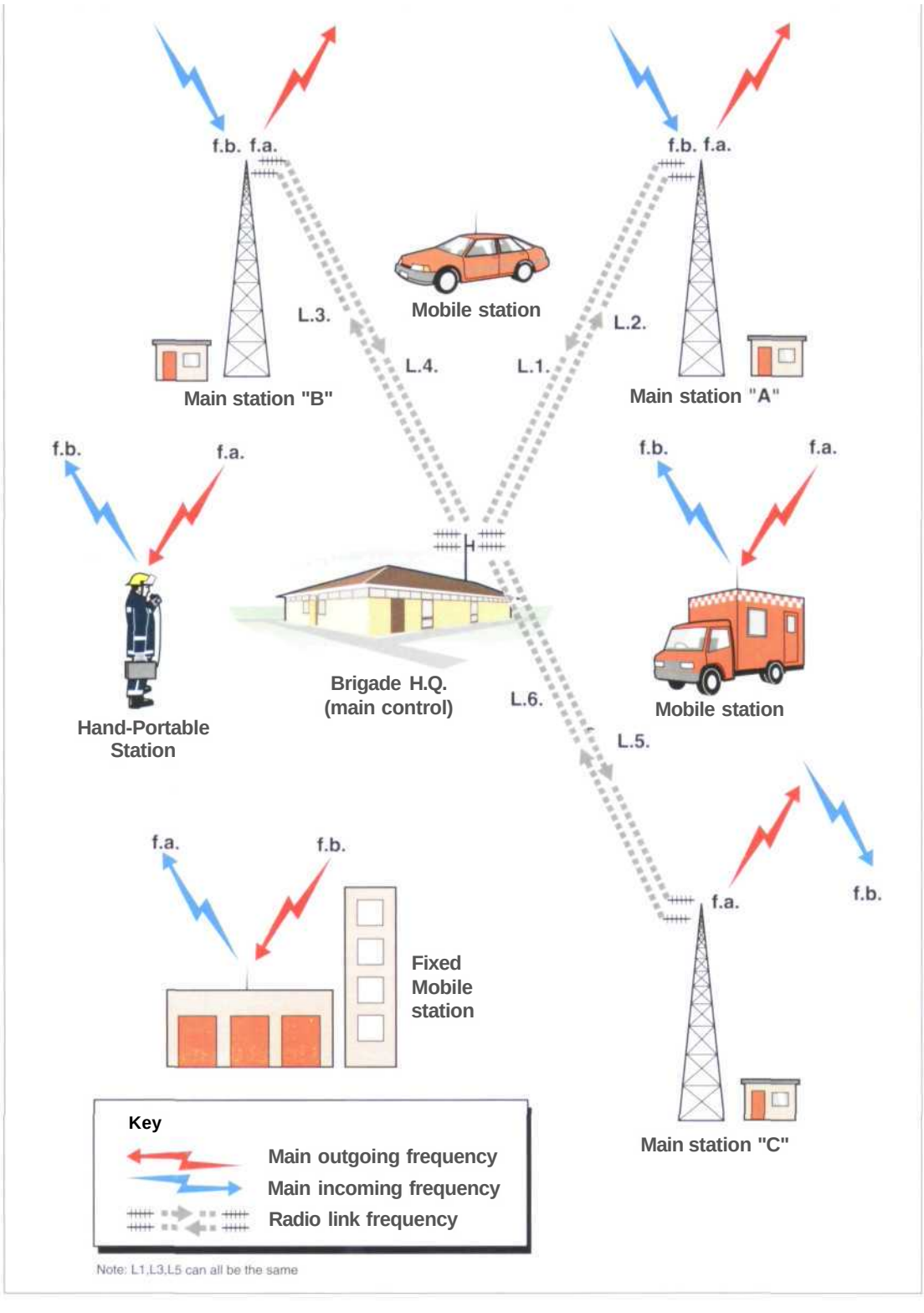


Figure I0.8 Multi-station double frequency area coverage scheme.

wide-area coverage radio schemes. In the example shown (Figure 10.8), a permanent assignment of eight frequencies is required with independent outgoing links to all stations, and this can only be reduced to six if they all share a common outgoing link, that is, two main frequencies and either six or four link frequencies to provide just one operational radio channel.

10.2.9 Equipment

It is normal practice in Fire Service radio schemes to provide two sets of equipment at every station, known as the 'main' and the 'stand-by' equipment. Basically, only one is operational at any one time and their purpose is to ensure continuity of service in the event of failure. Change-over from 'Main' to 'Stand-by' equipment and vice-versa is normally under the control of the control station operator or supervisor. In addition, every station will have several items of ancillary equipment.

At the main control station of a radio scheme, facilities are provided to enable control room staff to isolate the main stations individually when for one reason or another they are troublesome (e.g., when a temporary, very high noise level is caused by the effects of static electricity during a severe storm in the vicinity of a site).

Remote control facilities are also provided to enable control room staff to switch main station equipment from 'Main' to 'Stand-by', such equipment can be changed either individually, i.e., just one faulty piece of equipment, or collectively, i.e., all equipment. In addition to the duplication of equipment, a further safeguard is normally provided against complete link failure, perhaps due to aerial damage. The equipment at all main stations is arranged so that in the event of a link failure the station changes to **'automatic talk-through'.**

This means that any signals received from mobiles by the main receiver are automatically re-transmitted to the mobiles by the main transmitter instead of, or in addition to, being transmitted via the link transmitter to control. This system provides some measure of service, which is better than none, until the faulty link can be repaired.

Under the automatic talk-through system the mobiles can at least talk to each other but the control is isolated if the link is completely severed. Even if the link still works one way the control will either hear what is going on without being able to participate or will be able to speak out without knowing whether anyone is receiving.

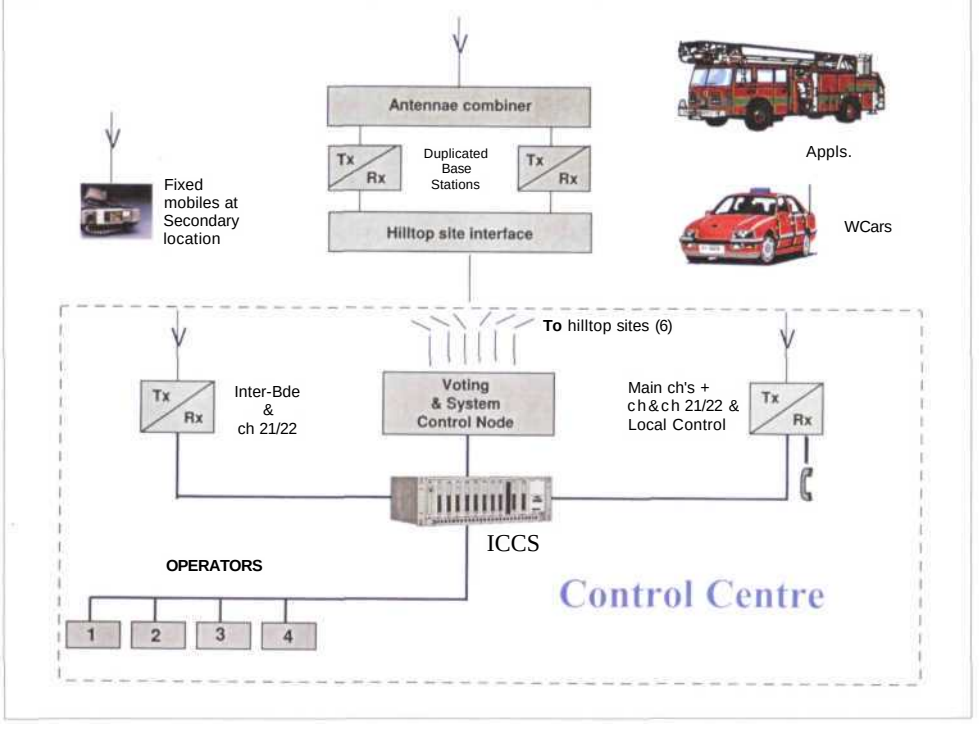


Figure 10.9 Voice infrastructure.

Voice Infrastructure

Figure 10.9 shows a typical voice communication system infrastructure which comprises a number of Control Officer operating positions, each of which is provided with a headset and microphone, a loudspeaker and means of making a radio channel selection. The operating positions provide the Control Operator interfaces to the Integrated Communication Control System (ICCS) which in turn provides access to individual radio channels and also to telephone circuits.

The Main Fire Service voice channel is broadcast on low band VHF from a number of hill top radio sites, at each of which is located either a single or duplicated Base Station. Each Base Station is connected to the control site by means of either a microwave link network or by a private wire circuit. At the control site the receive and transmit signals are brought together in a Voting unit. The main purpose of the voter is to accept all of the receive signals from the hill top sites and select (vote) the best signal to pass to the ICCS.

A local base station at headquarters is connected to the ICCS to provide for fallback control of the main VHF channel when it is operating in talk-through mode, by operating on the mobile frequencies. This base station may also provide communication on fireground channels 21 and 22 in the locality of Fire HQ. Further levels of fallback protection are also provided by means of a desk mounted mobile radio located at Fire HQ or at an alternative location.

A local base station at headquarters is also connected to the ICCS. This provides for inter-Brigade communications with adjacent county Fire Services.

10.2.10 Fixed Mobiles

A unit can either be fixed or mobile but it cannot be both. However, in the radio sense, a 'fixed mobile' is a radio transmitter/receiver which has all the attributes of a mobile radio (it might even be physically identical) except that it is installed in a fixed location, within a building, instead of in a vehicle. Such a unit transmits on the 'mobile' transmit frequency and receives on the 'main station' transmit frequency. Transmissions from such a unit are received by control in exactly the same way as transmissions from true mobiles and, apart from an identifying call-sign, are totally indistinguishable from them. Within the context of a mobile radio scheme the expression 'fixed mobile' is, therefore, quite logical and understandable.

If a 'fixed mobile' is installed in, or can be operated from, the control room then, in the event of total link failure, a control room operator will be able to fully participate in whatever remains of the radio scheme through the 'auto-talk-through' facility. In this context, the 'fixed mobile' may alternatively be described as 'reverse frequency' equipment because its transmit and receive frequencies are the reverse of those for the normal outgoing and incoming control channels. It can also be used as a realistic way of checking hill-top site performance within radio range of control.

Although individual fire brigade systems are totally independent, it is very useful, for the control rooms at least, to have access to the schemes of neighbouring brigades. This facility is useful when incidents occur over brigade boundaries or when assistance is sought at large incidents. Such access is also provided by a 'fixed mobile', each control room having a radio which operates on the mobile transmit and receive frequencies of the neighbouring brigade(s).

The fixed mobile originally supplied by the Home Office can also be programmed with the two-man-pack frequencies (Channels 21 and 22) allowing, when radio range permits, direct radio communications in an emergency when main scheme failures occur, between control and vehicles.

10.2.11 Main Control

A radio scheme with a considerable number of users all operating on the same channel is almost unworkable unless one station is made responsible for its overall control. That station is known as the 'Main Control', or simply 'Control'. The 'two-frequency' system automatically gives the control station the ability to 'dominate' all other radio scheme users. Normally they can only hear control and not each other unless talk through is a permanent arrangement.

In the Fire Service the main radio control is invariably in the centralised mobilising control room for the brigade, whilst the radio equipment is located in an adjacent room or building known as the 'link room'. Outside is a tower or mast on which the directional link aerials, each pointing at a distant hill-top site, are fitted, along with simpler aerials for any 'fixed mobile' equipment in the control complex.

The control equipment will be duplicated at two or more operating positions, the number of such positions depending upon the size of the brigade and the number of separate radio channels it uses.

10.2.12 Transportable Equipment

'Mobile' equipment in 'hand-portable' form can either be in a briefcase, haversack or 'backpack'. It operates on the mobile transmit and receive frequencies and contains its own (usually) rechargeable batteries. It permits direct contact with control whilst away from a parent vehicle and is an alternative to the personal radios. Because of the lower transmitter power, imposed by the limited weight for the batteries, and the less effective aerial, this type of equipment is not as good as a vehicle radio particularly for transmitting back to control.

10.2.13 Power Supply Arrangements

The control and main scheme radio equipment at the control station, and all the radio equipment at hill-top sites, are operated from the normal domestic electricity supply of 230 volts, 50 Hz, AC. Fire Service personnel should be aware of the potential danger arising from the presence of such voltages and should **never attempt to go inside any equipment.**

At all key stations there will usually be a stand-by power supply in the form of a diesel driven generator with automatic start-up and change-over to ensure the scheme is never put out of action by a mains supply failure.

'Fixed mobile' equipment may be designed to operate direct from the AC mains, i.e., genuinely fixed equipment made to operate on 'mobile' frequencies, or it may be a 'mobile radio' made to operate from a vehicle battery, 12 volts, DC, with a 'mains power unit' made to operate from a vehicle battery, 12 volts, DC, with a 'mains power unit' which converts 240 volts, AC, direct to 12 volts, DC, without the need for a battery.

10.2.14 Microwave

In the section on 'scheme engineering' it was explained how as many as eight separate frequency channels are required in a three-station scheme to support just one operational channel for a brigade. Additional stations require at least one additional frequency (possibly two) whilst an additional operational channel will require a complete additional set of frequencies. Only two of the frequency channels supporting each operational channel are used to actually communicate with the mobiles - the main outgoing and incoming frequencies shown as 'f.a' and 'f.b' in Figure 10.8. The remainder are 'link' frequencies, shown as L1 to L6 in Figure 10.8 and they serve to carry speech, on a point-to-point basis, between the control station and the hill-top sites.

Until very recently the frequencies used for link channels have always been in either the VHF band or the lower part of the UHF 2 band. An obvious disadvantage is that frequency channels which are ideally suited for mobile communication on a broadcast basis are being used for point-to-point links and, with the intense competition and demand for additional mobile channels, that 'waste' of mobile channels can no longer be tolerated.

To release currently used VHF and UHF 'link' channels for 'mobile' use, regulations now require that all new point-to-point links shall immediately operate in the **microwave** part of the frequency spectrum and that all currently used VHF and UHF 'link' channels shall be moved to microwave as part of a 'rolling plan'.

Definition

The term 'microwave' is one which has no precise and universally accepted definition which fits in with the generally accepted frequency and wave bands given in Figure 10.3. However, for our purposes, 'microwaves' means frequencies above 1000 Mhz (1 Ghz), that is wavelengths shorter than 0.3 metre (30 cms). 'Microwave' ovens operate at 2.45

Ghz so the frequencies which will be used for emergency services links - in the range 1.8 to 2.3 Ghz - can be legitimately described as 'microwaves' although Figure 10.3 clearly shows such frequencies to be in the upper part of the UHF band.

As far as the operational user of a radio scheme is concerned, its linking arrangements - its 'scheme engineering' - should be completely transparent, in other words operationally 'invisible'. The user may work on the assumption that radio signals pass directly between the vehicle aerial and the mast at brigade HQ, although it is better to appreciate the limitations of radio communication over the ground, and the need for linked multi-station schemes.

Limitations

At microwave frequencies, an unobstructed line-of-sight path between aerials at opposite ends of a link, is essential. This is in contrast to VHF links for which a degree of obstruction from hills, trees, or buildings, was acceptable. As a result it is not always possible to replace a VHF link path with an identical microwave link path. Some reconfiguration, either re-routing between existing stations or additional stations, may be necessary. In VHF linked schemes every effort was made to link every main station (hill-top site) direct from control in a radial 'cartwheel spoke' configuration.

That was not always possible and in some cases a very remote main station is linked to control through another main station which is then known as a 'master' station or 'repeater' station. With increasing congestion of the VHF band, the use of 'master' or 'repeater' stations was becoming progressively unworkable, but the move to microwave has removed that particular problem, and microwave links are equally likely to be arranged in a 'daisy-chain' configuration.

Microwave links are wide-band in contrast to VHF links which were narrow-band. In this context narrow-band is 12.5 kHz, just one channel width, whilst wide-band is several hundred kilohertz which is many channel widths. This means that it is possible for a single microwave link to carry many separate speech channels using a technique known as 'Multiplexing'.

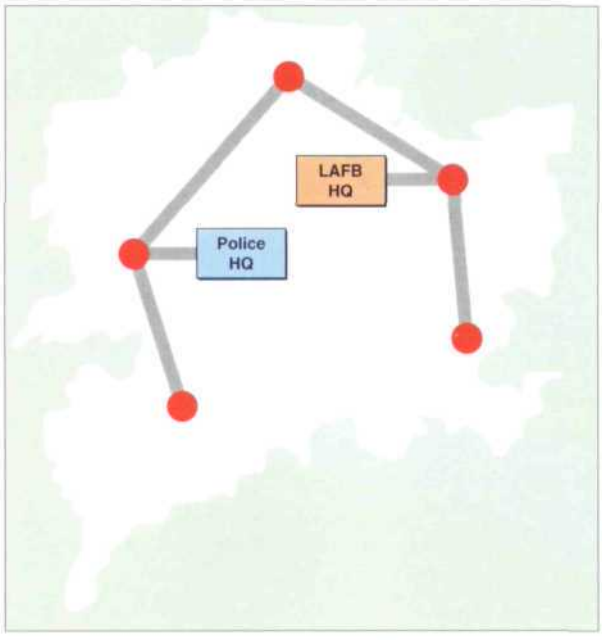


Figure 10.10 Micro-wave link in 'daisy-chain' configuration.

10.2.15 Multiplexing

'Multiplexing' on a wide band microwave link does not save on frequency spectrum occupied because the total width of a number of multiplexed channels in a single wide band channel is greater than the sum of the widths of the same number of channels in individual narrow bands. The big saving is on equipment - one anologue microwave link can, for example, carry up to 36 separate speech channels — and on the number of aerials required on the masts.

The multi-channel capability results in another potential change in linking philosophy. Whereas in the past all the individual emergency services have had independent radio systems with perhaps their equipment in different rooms or even different buildings at hill-top sites, microwave linked systems planned on a 'combined user service area' basis to meet all the operational requirements of all sharers. Each system will be designed individually taking into consideration:

- Topography of coverage area, e.g. a county or counties.
- Disposition of existing, and possibly future, hill-top sites.

- Disposition of operational controls, e.g., Fire and Police Headquarters etc.

- The number of channels and the routing required by each user. Figure 10.10 illustrates a possible linking arrangement with Fire and Police HQs in different parts of the county.

10.3 Mobile, Transportable and Personal Radio Equipment

10.3.1 Conventions

Although the actual use of individual channels is not subject to regulations there are obvious dangers if there is not disciplined use. **DCOL 4/88 (in Scotland DFM 5/1988)** recommends that use of channels should be identified.

DCOL 6/1992 Item 12 Appendix 1 (in Scotland DFM 4/1992) recommends the primary and secondary use for each channel.

Since 1 January 1993, 6 UHF 'at incident' channels and 2 VHF channels have been available, in addition an inter-agency channel is provided. Other users, such as airport fire brigades and works fire brigades may be permitted to use one channel if the local authority Chief Fire Officer/Fire Master considers this could improve operational efficiency and subject to the approval of RFCPU.

This, for instance, enables an airport fire officer instant radio contact with responding local authority appliances equipped with UHF facilities.

10.3.2 Mobile Equipment

The World Administrative Radio Conference in 1979 directed that all emergency services in the UK still operating in the 88-108 Mhz VHF Broadcast Band must move to alternative bands by the end of 1989. Conversion of old equipment to operate in the new bands was not considered worthwhile and the opportunity was taken to re-equip and standardise.

Current mobile equipment for the Fire Service normally receives in the 70-72 Mhz band and normally transmits in the 80-82 Mhz band.

Figure 10.11 A typical vehicle radio control unit.
{Photo: Simoco)

The standard 'mobile radio' consists of two main parts:

(1) the transmitter/receiver unit; and

(2) the control unit.

The transmitter/receiver unit is the larger of the two and is placed within the vehicle. The smaller, control unit is mounted in a convenient position for operation by the driver and/or the front seat passenger. A multi-core control cable with multi-way plugs or sockets connects the two units together. Connected to the control unit are the handset and the loudspeaker. Provision is made for two loudspeakers so that one can be fitted in the cab and one at the rear of an appliance if required. Connected to the main unit are the aerial and the battery.

Installation

The installation of radio equipment in all vehicles (motor cars in particular), is controlled by the requirements of Health & Safety and compatibility (non-interference) with other sophisticated vehicle electronic systems which are now fitted as standard equipment.

'Standard fits', in which the precise location of every part of the radio equipment is defined, should be agreed by the vehicle manufacturers, the

Fire Service and the service provider. The staff who actually install the equipment have no authority to deviate from the 'standard fits' because, in attempting to meet the wishes of vehicle owners, a physically or electrically dangerous situation may result.

Further guidance on installation of mobile radio equipment in fire appliances is available from RFCPU.

10.3.3 The Aerial

It is a truism that any mobile radio is only as good as its aerial, hence the design of the aerial, and its location on the vehicle, largely determine the overall performance obtained. The type of VHF aerial currently fitted on fire mobiles is known as a 'quarter-wave rod', its length being almost exactly one quarter of the transmitted wavelength.

For a transmitter frequency of 80-82 Mhz, the wavelength is about 3.66 metres, so a quarter wavelength is just under one metre.

Ideally the aerial should be mounted in the centre of a flat electrically conducting (i.e., metal) surface, such as the roof of a car or van.

Many modern fire appliances have fibre-glass bodies and it is customary for an area of metal foil or mesh to be moulded into the roof of the cab during manufacture to which the aerial must be fitted. If other roof-mounted equipment, such as ladders, are fitted first, care is needed to avoid encroaching on the critical 'aerial space'. Metal close to the aerial will absorb the radio energy resulting in inferior performance.

The aerial is connected to the transmitter/receiver unit by a coaxial cable, similar to that used to connect a TV aerial to a TV set. The performance of such cable is impaired if it is sharply bent or squashed even though there may be no visible sign of damage.

10.3.4 Channel Selection

The mobile radio (as originally supplied by the Home Office) has the capability of accessing up to 255 channels but, at the time of writing, only a limited number are used. Channels 1 to 20 are 'brigade allocated' and each brigade has made its own selection. The brigade's own channel or channels will normally be on channels 1, 2, 3, etc., as required, followed by the channels of neighbouring brigades by mutual agreement. Channels are selected using a numerical key pad and the illuminated display will show the channel number entered.

Channel numbers 21 and 22 are allocated for working both with man-pack VHF radio equipment and directly between vehicles fitted with suitable radio equipment.

10.3.5 Squelch

All mobile radios operating at VHF (and UHF) have an automatic'squelch' or 'mute' which completely switches off the receiver output to the loudspeaker and earpiece when no transmission is being received. The 'squelch' is necessary to suppress the noise which would otherwise be heard in the absence of a signal. The receiver automatically 'opens up' when a signal of sufficient strength to over-ride the noise and give an intelligible output is received. An incorrect setting of squelch levels aimed at reducing unwanted noise could mean that very weak operational signals will not open up the receiver.

10.3.6 Transmission Timer

To avoid the risk of the transmitter being permanently locked on transmit due to a faulty handset pressel switch or the handset falling into a position where the switch is jammed on, the transmitter is fitted with an automatic transmission timer. A jammed-on transmitter would block the complete radio scheme, and, being 'simplex', the receiver would be inactive so that no signals could be received. The transmission timer automatically switches off the transmitter after about 30 seconds continuous operation. Normal transmissions rarely last that long but, if necessary, the pressel switch is simply released and pressed again to continue transmitting. The 30 seconds time-out applies to Home Office supplied mobile radio equipment. However, similar principles, but possibly with actual different time-outs, will normally apply to all transceiver equipment.

10.3.7 Power Supplies

The standard mobile radio is designed to operate from the standard 12-volt DC vehicle battery source. Connection is made between the transmitter/receiver unit and the vehicle battery via a heavy duty two-wire cable with a suitable fuse in the 'non-chassis' (usually positive) wire, the fuseholder being as close to the battery terminal as possible. The use of two wires, avoiding 'earth return' through the vehicle chassis, helps with equipment 'compatibility' by reducing the risk of mutual interference with vehicle electronic systems.

No problem arises in standard 12-volt vehicles but many larger vehicles and fire appliances have 24-volt electrical systems. Radios can be built to work off 24 volts, but it is not economic to have two standards so 24-volt vehicles are fitted with 12-volt radios.

There are two ways in which this can be done:

(1) **By battery tapping.** The 24 volts is normally provided by two 12-volt batteries 'in series' so the radio can be connected across the 'lower' one (the one with one terminal to chassis). This works reasonably well, although the battery supplying the radio will be discharged more than the other one and this can cause battery maintenance problems. The main disadvantage of this method is the risk of a vehicle mechanic, unfamiliar with the unusual arrangement, re-connecting the radio across the full 24 volts when replacing the batteries. This method is, of course, not possible if the 24-volt battery is a single unit with no access to the intermediate 12-volt point.

(2) **By using 24-volt to 12-volt converters.** These units, which are readily available, are easily fitted to 24-volt vehicles and are far more satisfactory. However, there are cost, installation and maintenance overheads to consider.

10.3.8 Fixed Mobile Version

A fixed mobile version of the standard mobile radio is available, designed to be fitted in a rack or cabinet in a building and powered from the normal 230-volt domestic AC mains supply via a power unit whose output is 12 volts DC.

The radio can be controlled either 'locally' at the rack or cabinet, or 'remotely' by a control unit designed to fit in a console or be free-standing on a desktop. Emergency power can be made available either via the building backup generator, from the uninterrupted power supply, or a direct 12v DC switchcable or plugged battery supply.

10.3.9 Special Features

(1) Single frequency working

The standard mobile radio normally works in the "two-frequency simplex' mode communicating with 'Control' over the main VHF radio scheme via the hill-top sites and the linking system. The outstanding feature of 'two-frequency' working is that the mobiles can only hear 'Control'; they cannot hear each other unless the control operator has engaged 'talk-through'. Direct 'mobile-to-mobile' communication is possible with 'talk-through' engaged, but that ties up the whole of the 'main-scheme'. The control operator may wish to monitor the messages, but all other mobiles are unnecessarily involved.

To provide greater flexibility the 'standard' mobile radio will have one or two 'single frequency' channels (usually channels 21/22) and any two or more mobiles switched to one of those channels will be able to communicate directly **and totally independently of the main scheme,** within a very limited geographical area. The size of the area will be almost entirely determined by the intervening terrain and is likely to be severely restricted in heavily built-up areas.

It is of course necessary to pre-arrange the switch to the single frequency channel. It is even more important to switch back to the normal two-frequency channel because there is no way in which 'Control' can contact a mobile switched to the single frequency channel. Under normal circumstances permission will be requested from 'Control' before a mobile switches to Channels 21 and 22. The fixed mobile can also operate on Channels 21 and 22 for direct emergency communications with mobiles when no other normal channel is available.

(2) CTCSS

CTCSS stands for 'continuous tone controlled signalling system'. It is an optional feature, already fitted in a small number of brigade hilltop receivers, mobile radios may be similarly fitted.

In the normal way the squelch or mute of a receiver is opened by the reception of a 'carrier' signal of adequate strength. The audio output of the receiver is then fed to the loudspeaker or earpiece to reproduce any speech modulation superimposed on the carrier.

This normal system works reasonably well but it has two disadvantages:

(1) There is no way in which individual mobiles, or groups of mobiles, can be called independently so that only those for whom a particular message is intended will hear it; and

(2) There are circumstances in which a radio receiver can be 'fooled' by natural or man-made radio noise' so that its squelch opens when no real signal is present resulting in a 'noise' output. This particularly affects main VHF scheme hilltop receivers which control rooms need to maintain a constant listening watch.

CTCSS overcomes those disadvantages by superimposing a continuous low-pitched tone upon the radio 'carrier' at the transmitter, in addition to the speech. The continuous tone is used to open the squelch at the receiver, after which it is 'filtered out' so that it is not heard at the audio output. In the outgoing direction (hilltop-to-mobile) different tones can be selected by the control operator and different mobiles, or groups of mobiles, will respond to different tones. This provides what is known as 'selective calling' in which only selected mobiles will receive the transmission.

When CTCSS is fitted to inhibit hilltop radio receivers, remote technical arrangements must be fitted to allow Control to switch off the brigade's CTCSS. This arrangement is necessary to allow non-CTCSS fitted mobiles to access the brigade's radio scheme upon such a request from the non-CTCSS fitted brigade Control.

10.3.10 Transportable Equipment

'Transportable' in this context, as distinct from 'mobile' or 'personal', means equipment which is completely self-contained with its own batteries and aerial, which can thus be transported from place to place and used anywhere, but which is usually set down, rather than operated whilst being carried, as is the 'norm' for personal equipment. The distinction is, however, somewhat vague and some transportable equipment is certainly capable of being used 'on the move' as is illustrated by the 'hand-portable' (see Figure 10.2).

The standard equipment has a 99 channel capability and the first twenty channels are 'brigade allocated' in the same way as a standard mobile. It also has the same 'single frequency' capability using Channel 21 or 22. It has all the features and facilities of a standard mobile except 'public address'.

The biggest demand on the battery is during 'transmit' and a compromise must be made between the transmitter power and the acceptable size and weight of the battery. Of necessity, the transmitter power is about half that of a standard mobile but in all other respects the performance is identical.

Figure 10.12 Hand-held radio in use.
(Photo: Hertfordshire Fire & Rescue Service)

10.3.11 Personal Equipment

'Personal' equipment is small enough to be carried in the hand or pocket, or in a suitable lightweight body-harness. Its small size means miniature construction techniques which create problem in the receiver, but which do create difficulties in the transmitter. The battery size is severely limited and those two factors restrict the transmitter power to a fraction of what is obtainable from 'transportable' equipment (normally approximately 1 watt in the majority of equipment). This, coupled with the restricted aerial dimensions and efficiency, limits the range of the transmitter section. The receiver performance will be comparable to that of a transportable under similar conditions.

Personal equipment can operate in either the VHF or the UHF band, but VHF equipment, other than in the single frequency mode, would normally be expected to transmit into the main scheme hill-top sites. VHF equipment is perfectly satisfactory on a single frequency basis to other personal, transportable or mobile units over short ranges, but in general UHF offers better performance for personal radios. The use of FM offers advantages for personal radios, if only because it permits greater transmitter power to be obtained from a given size of battery, and all UHF personal radios used within the fire service operate on FM.

10.3.12 Methods of using Personal Radios

Personal set communication can be organised in a number of different ways to meet various operational needs which, in broad terms, break down into the following categories:

- Direct person-to-person communication on an exclusive single frequency channel over very short distances e.g., between individuals at an incident, or when carrying out dry riser tests - or other duties - in high rise buildings.
- Similar communication but in which one of the units is mounted in a vehicle.
- Two-frequency communication between personal sets via a vehicle-mounted or portable VHF repeater.
- Two-frequency communication between personal sets and the brigade control room via a vehicle-mounted UHF/VHF repeater.

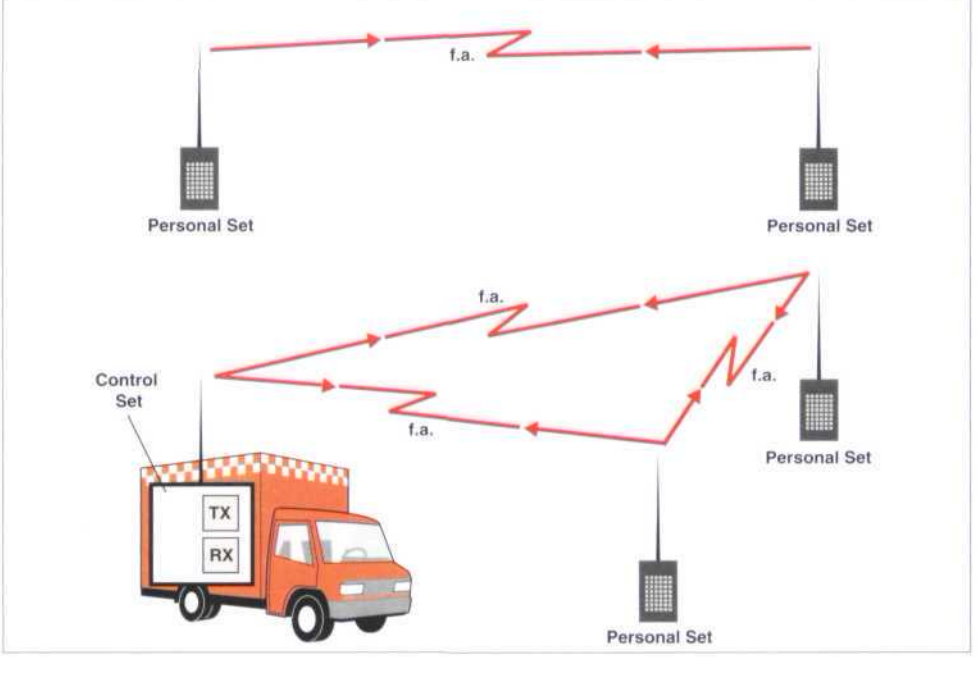
Single Frequency Operation

Figure 10.13 (1) involves personal sets only and, although only two are shown, any number can be used on an 'all-hear-all' basis subject to the limita-

Figure 10.13

(1) Single-frequency personal set usage.

(2) Single-frequency personal sets with control set.



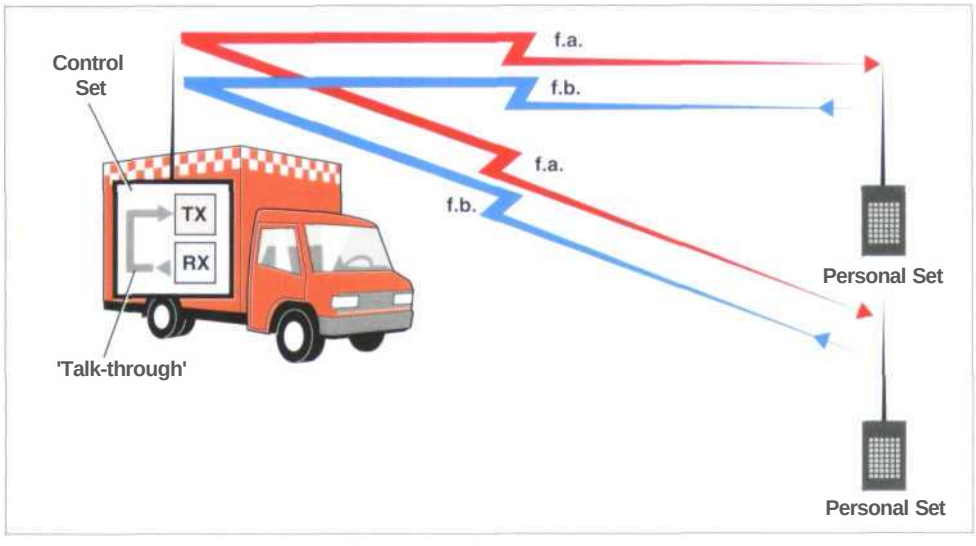


Figure 10.14 Double frequency personal set usage with control set on talk-through.

tions of range imposed by location and environment. With more than two units it may well be the case that unit 'B' can communicate perfectly with both unit 'A' and unit C whereas units 'A' and 'C cannot communicate directly at all.

When switched to a single frequency channel a personal radio transmits and receives on the same radio frequency and, when used without the aid of any control station equipment, has the following limitations:

(i) Its effective direct range between individuals is seriously affected by the screening phenomena. Therefore, the general range and performance must be expected to vary constantly as the individuals move about.

(ii) It is not possible to forecast accurately what the performance will be in any particular building or other environment, and it does not follow that because good results are obtained in one building, similar results will necessarily be achieved in a nearby and similar building.

To summarise, performance can be expected to vary from one extreme, where screening is severe and when communication even over very short distances is unreliable, to the other extreme where there is little or no screening, good communication over several miles is not uncommon.

Figure 10.13 (2) illustrates the use of a control set using single-frequency equipment. Provided the control point equipment is well sited and has an efficient aerial, this arrangement has the advantage that working range between the control point and individual personal set users is greatly improved. However, with single-frequency working, effective range between individuals depends upon them being within direct range of each other, this arrangement will not improve person-to-person communication. The control set operator could, however, personally relay messages from one personal set user to another where they are not within direct working range.

It should be noted that when a user is transmitting, they will not be able to hear calls from other users.

Two-Frequency UHF Personal Set Channels

UHF multi-channel personal equipment with three or more channels has been adopted by most fire brigades for fireground purposes. Four of the six channels utilise single-frequency working and two utilise a two-frequency channel. The two-frequency channels cannot be used for direct person-to-person communications without a suitable control set. Figure 10.14 illustrates the arrangement which is adopted when using two-frequency personal set channels. All outgoing transmissions from the 'control' set are on one frequency (f.a.) and all incoming transmission from 'personal set' users are on another frequency, (f.b.). Therefore, since all 'personal set' receivers' two-frequency channels are tuned to frequency (f.a.) they cannot hear transmissions direct from other 'personal set' transmitters, which are tuned to frequency (f.b.).

Nevertheless, this arrangement has advantages over single-frequency working especially when there is a need to increase working ranges between individuals. This is achieved by a "talkthrough" facility on the 'control set' for use when it is necessary to automatically re-transmit on the outgoing frequency (f.a.) all incoming signals received from 'personal set' transmitters on frequency (f.b.). When the 'talk-through' facility is off, the 'control set' operator will hear and be able to communicate with all 'personal set' users within range, but 'personal set' users will not be able to hear each other.

There is no reason why the 'control set' should not be switched to 'talk-through' on the two-frequency channel and left unattended when the requirement is for good communication between 'personal set' users. All six channels may be used simultaneously at the same incident without mutual interference.

The 'talk-through' facility provides considerably enhanced range between 'personal sets' above that obtainable with single-frequency working because of the greater performance of the vehicle-mounted or 'portable set' and its aerials.

It is customary to designate the direction from control as 'outgoing' and the direction to control as 'incoming'. The equipment thus has a true control function, exactly the same as that which the brigade control room has over the main VHF scheme, hence the operator at the fire ground can control the miniature UHF scheme in just the same way. Vehicle-mounted sets are normally fully duplex, usually with separate transmit and receive aerials although it is possible to use a single aerial with an additional unit, known as a 'duplexer' which enables the transmitter and receiver to operate independently and simultaneously with a single aerial.

The conditions of licence, under which frequencies are allocated and radio communications authorised, restrict the use of Fire Service personal sets to low power, short range communications. In consequence, the setting up of fixed base stations on 'personal set' frequencies, VHF or UHF, to give greater working ranges (for example, throughout a town or city) is not permitted because of the risk of causing interference to other brigades in neighbouring areas.

Normally there is no operational requirement for permanently engineered Fire Service 'personal set' schemes similar to those which are an operational necessity for the police. The normal Fire Service requirement is the need for completely portable short range systems which can be set up and brought into use at very short notice anywhere at incidents.

At specific locations fixed UHF base stations (repeaters) may be authorised by RFCPU for use in road tunnels or airports, etc. However such use is strictly limited according to the stated operational requirement when the licence was granted.

10.3.13 Composite Units

A vehicle with a mobile UHF control unit will usually have a VHF mobile radio fitted, and an operator in the vehicle can then communicate with both the 'personal set' users and the brigade control room. An added facility is an interface, usually in the form of a combined UHF/VHF control unit which connects to both transmitter/receiver units.

The equipment collectively is now known as a 'VHF/UHF Repeater Unit", and it can be used in three distinct ways:

(1) Local control of a two-frequency UHF network and VHF communication with brigade HQ, but not simultaneously because although the repeater control unit has two loud-speakers, it has only one handset which is switched to VHF or UHF as required.

(2) Talk-through between 'personal set' users with the vehicle set unattended or, with the vehicle operator solely involved with VHF communication to the Brigade HQ.

(3) With the vehicle control unit switched to 'repeat', all signals received on VHF are retransmitted on UHF and vice versa so that the •personal sets' all hear brigade HQ just like a mobile or transportable, and individual personal set users can speak directly back to Brigade HQ.

In (3) above the vehicle will usually be unattended or at least without a designated operator, and it can

be arranged that when on 'repeat' the two loudspeakers are switched off to prevent unauthorised listening-in'. One minor drawback of the repeater is that personal sets are not able to directly communicate with each other; the vehicle VHF radio is 'simplex' and its receiver switches off when transmitting. When a personal radio transmits, the UHF receiver in the vehicle switches on the VHF transmitter back to control, and the VHF receiver is switched off. The UHF transmitter to the personal sets therefore also switches off and they appear to go 'dead'.

10.3.14 Personal Hand-Held Radio Sets

A limited number of frequencies are specially allocated on a national basis for use by fire brigades, some in the VHF band and others in the UHF band. Fireground communication is presently carried out using the UHF band of frequencies. Personal hand-held equipment is normally designed to accommodate a minimum of 3 channels. However, with the allocation of 6 UK-wide Fire Service UHF frequencies for their exclusive use and possible additional channels for other purposes, there is a need for synthesised multi-channel equipment which, for a number of years, will be used in addition to existing 3-channel equipment.

10.3.15 Intrinsically Safe Personal Radios

Ordinary personal radio equipment is capable, in flammable atmospheres, of causing explosions or fire. Intrinsically safe equipment is designed, when correctly used and maintained, to operate safely even if it develops a fault. Personal radios certified to BS 5501 Part 7 or European Standard EN50 020 for Category ib. Group IIC and Temperature Class T4, provide the minimum standard that should be used. The harmonised standard CENELEC Eex ib IIC T4, is often referred to and equally valid. (See DCOL 8/95 Item A, in Scotland DFM 6/1995 item A.)

Each user should satisfy themselves that this equipment is suitable for use at incidents in their area. If in any doubt about the suitability or use of their equipment then H.M. Fire Service Inspectorate should be consulted.

10.3.16 B.A. Radio Communications Interfaces

Fire Service Circular 3/75 recommended that all future purchases of B.A. should comply with BS 4667 and should be covered by a Certificate of Assurance (C. of A.) issued in accordance with the Joint Testing memorandum.

From 1 January 1990, under COSHH Regulations, BA equipment has to be suitable for its intended use and approved by the HSE. It will be certificated under HSE Testing Memorandum No. 3 (TM3). New CEN standards will apply when they become available.

Any fitting must have the prior approval of the manufacturer who, as the holder of the C.of A., can ensure that, if any amendment to the C. of A. is required, it will be HSE approved.

10.3.17 Disadvantages of use of radio with B.A.

Firefighters should particularly bear in mind that there are disadvantages to the use of radios with BA.

- Radio signal penetration in some types of buildings can be limited.
- Some atmospheres are so potentially hazardous that only communications equipment with the highest standard of explosion protection should be used.
- Radio systems can operate explosive devices designed to be operated remotely.
- Radio transmitters may interfere with building control systems.

10.3.18 User Discipline

The increased use of BA fireground radio generally, requires good radio discipline. A very complicated radio call-sign system could interfere with operational flexibility and command at an incident and, therefore, self-evident call-signs are recommended. Call-signs, however, should be such that the brigade can be identified from them, especially in a multi-brigade incident.

The possibility of cross-incident and inter-brigade interference from the use of over-powerful transmitters should be guarded against.

The transmit/receive ratio of the use of radio should always be considered. Transmissions should, wherever possible, be of short duration with an adequate pause to allow other users of the frequency, with perhaps a higher priority message, to transmit.

It is not possible for two UHF repeaters or mobile base stations on the same channel to operate simultaneously within range of each other. Therefore, it is essential that, where this happens, the repeater/base station in the least advantageous location is switched off.

Regulatory approval must be obtained from RFCPU before specifying the installation of fixed UHF equipment which will be left permanently switched on.

Radio communications could be required to operate deep within an underground railway system, railway tunnels, building sub-basements and other complex constructions. **The potential of deploying 'throw-out' and 'inbuilt' leaky-feeder systems should be considered even during the early stages of an incident.**

A great deal of research is currently underway to improve underground radio communications.

10.3.19 Security

Modern hand-held radio equipment is of significant financial value and can also be of great value to others, outside the service, if used unlawfully. Accordingly, radio equipment should never be left unattended on appliances unless it is suitably secured against theft.

Handheld or portable radios should never be left exposed to public view in unattended cars, even if the car is secured.

Arrangements for securing handheld radios on appliances will vary between brigades. Suitable arrangements could, for example, include a locked container secured in the appliance from which the radio can be taken when required.

10.3.20 Care Of Hand-Held Radio Equipment

The initial purchase of any handheld radio equipment should include suitable protective carrying cases. The design chosen must take account of local requirements. Even if the equipment procured is water-resistant the protective case should be designed so that it minimises the chances of the battery terminals/connections, aerials or controls coming into contact with water or spray. This is particularly important where the design of the radio equipment is such that water can collect near any of these fittings.

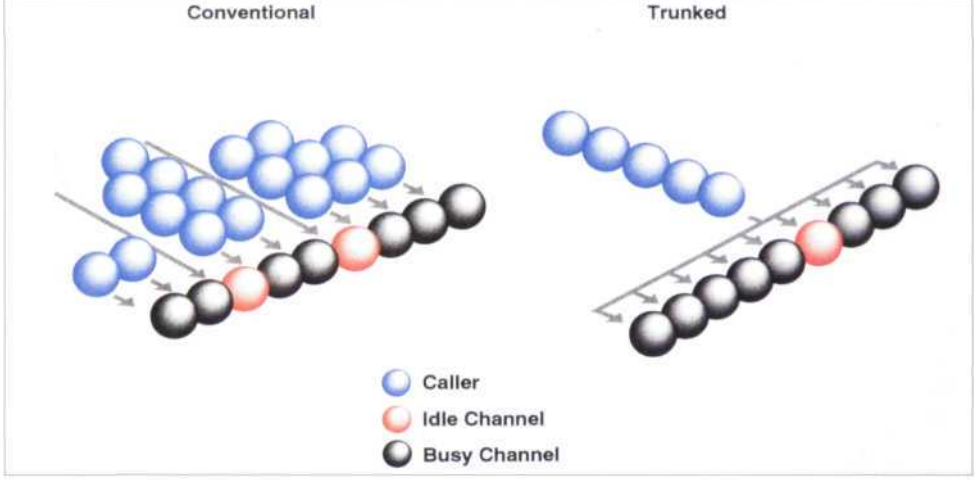


Figure 10.15 Trunking concept.

Virtually any electrical or electronic equipment will fail if subjected continually to heat in excess of that in which it was designed to operate.

Battery compartments of radio equipment should be kept closed (and locked in the case of intrinsically safe equipment) except when batteries are being changed. Batteries of explosion protected equipment must never be changed within the hazard area.

Radio equipment should be carried in such a way that it cannot easily be dropped, strike another solid object, become exposed to water, water spray, corrosive chemicals, or be subject to any unnecessary or abnormal mechanical stress.

Radios should not be carried in containers with other metallic objects which could make accidental connection with battery charging or other external radio connections. When external equipment not connected to any socket, a protective cover should always be in place over the exposed connectors.

10.4 Trunked mobile radio systems

The growth in mobile radio systems over the years, and the subsequent demand for frequencies has placed an ever increasing load on the spectrum managers. The concept of 'Trunked' radio schemes goes far in addressing this problem.

'Trunking' makes greater use of the available channels, but leaves users less aware of the congestion on that channel. Users share a pool of channels and are only allocated a channel when they need to make a call. In practice not all users wish to make a call at the same time, and 'trunking' theory is based on the probability that there will be free channel when required.

The telephone networks have been using 'trunking' theory for a great many years, but it has only recently become economically possible in radio systems with the advent of microprocessor circuitry.

Fundamentally, 'trunked' radio systems are engineered in a similar way to cellular telephony systems, with coverage being modelled in polygon shaped cells, although it is of course possible that area coverage is satisfied by a single trunked basestation. A mobile radio will be constantly "speaking" to its local basestation via a control channel.

When the mobile wishes to send a message the control channel will allocate a speech channel dynamically, and communications will be available. At the end of the transmission, and at each subsequent transmission different channels may be used. Once the transaction is complete these channels would then be available for other users.

Unlike cellular systems which are generally designed to be a one to one service, 'trunked' radio schemes can set up user groups in which multiple users will be able to talk.

'Trunked' radios permit 'roaming' throughout the area required, with handover between radio cells as a mobile passes from one base station area to another. The mobile receiver will be constantly hunting for a control channel during this exercise. Once a signalling channel is identified the signalling information is examined and checked by the mobile, and if validated, locks the mobile to this channel. This process happens automatically, and transparently to the user.

In the UK, the MPT 1327 signalling standard is used to facilitate analogue 'trunked' private mobile radio services in "Band **III**" (174-225MHz) although there is no reason why 'trunked' systems could not operate in different frequency bands.

Future development in trunked systems is currently being addressed by ETSI under the remit of the Trans European Trunked RAdio project (TETRA) which will be a digital TDMA product, with an effective bandwidth per voice channel of 6.25KHz, giving four time slots possible within the 25KHz bandwidth.

TETRA will operate for the Emergency Services in the band 380-400MHz, and commercially by PAMR service providers in 410-430MHz.

Chapter 11

Chapter 11 - Radio Alerting System

Currently Brigades use alerting systems to the Home Office MG4 specification. This forms the final link in the overall mobilising system. The simple schematic below indicates the system elements involved.

Mobilising and Communications components of the overall system are dealt with in detail elsewhere in this publication. But in the interest of understanding the Alerter system itself a brief outline may be of help.

The Mobilising system contains a large amount of detail covering the whole of the Brigade and this is available to Fire Control Officers when assessing the operational needs of any particular incident. Having determined a station or stations to be turned out, the detail concerning the incident location, the appliances to attend and, if **Wholetime,** the operation of sounders or, if **Retained,** the operation of alerters, is passed to the Communications Processor.

The Communications Processor makes use of a further Home Office Protocol called GD92 which specifies the way the processor works and the facilities it must provide. It will normally have a number of communication links, known as 'bearers', between Control and the stations and will use these on the basis of laid down preference and availability. The types of 'bearer' available to such systems can change as technology makes them available and cost effective.

The station end GD92 is similar but on a smaller scale and serves to interpret incoming instructions and operate printers, sounders, lights, doors, appliance bay indicators, etc. In the case of stations with a retained element instructions from the GD92 unit are passed to the **Alerter** using the MG4 protocol.

11.1 Alerter - General Description

The requirements of an Alerter system have not changed in essence since radio alerting was introduced. The fundamental need is still to call a retained crew to a station in the case of an incident or to send a test call to the alerters. What has changed is the means and the method of operation resulting in greater detail concerning a calls progress being available at Control.

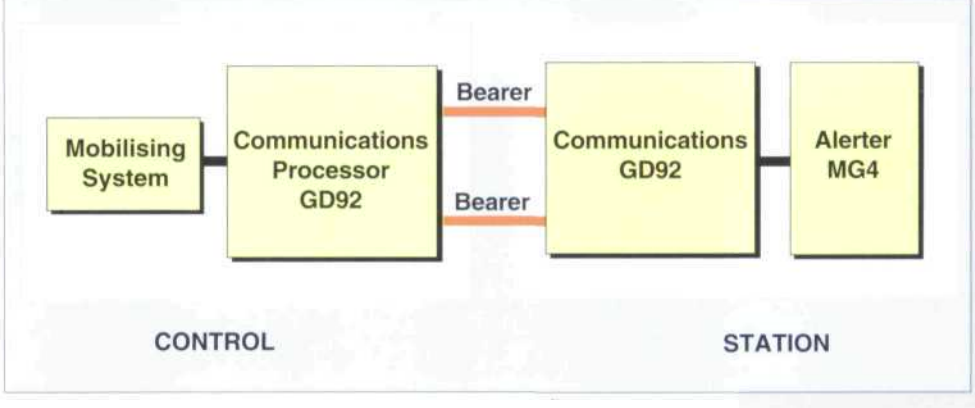


Figure 11.1 Radio alerting system to the Home Office MG4 specification.{Graphic:Muliitime)

It is not always the case that an MG4 alerter is installed at the same time as the Communications system is upgraded to GD92. In general, older Mobs/Comms systems presented simple relay contact closures to the Alerter and expected a simple relay contact closure in return to indicate a successful or failed call. MG4 systems have to be able to operate in this mode leaving the more advanced MG4 signalling protocol to be implemented at a later date. This gives a Brigade the flexibility to upgrade the overall system on a staged basis.

There are basically two component parts to the system, an encoder and a transmitter. The encoder generates the call required and the transmitter sends it to the alerters. It was common practice with the previous alerter bays to use two transmitters in a main and standby configuration. This has all but disappeared with the new MG4 alerter systems on the grounds that modern transmitters are far more reliable, but the facility is still available giving Brigades the opportunity to take financial advantage of the improved technology and still use dual bay at certain locations if operational needs dictate.

Standby power is required to cover for the eventuality of mains supply failure and normally this would take the form of batteries designed to give the Brigades stated period of operation. However, various options are available and a choice depends on the period of backup and whether or not other devices share the backup source, for example, the GD92 Comms unit. The charging of such batteries would be by stand alone equipment or perhaps via one of the units already part of the system. This is dependant in part on individual suppliers and their particular approach. Although there is **flexibility** in the type of power supply that can be provided, and Brigades may request backup periods less than the MG4 recommendation, suppliers must be in a position to achieve the 24 hours if requested.

11.2 Encoder

This component of the Alerter carries out the fol lowing basic functions:

- Provides two way communication, using MG4 protocol, with the station GD92 Comms equipment.

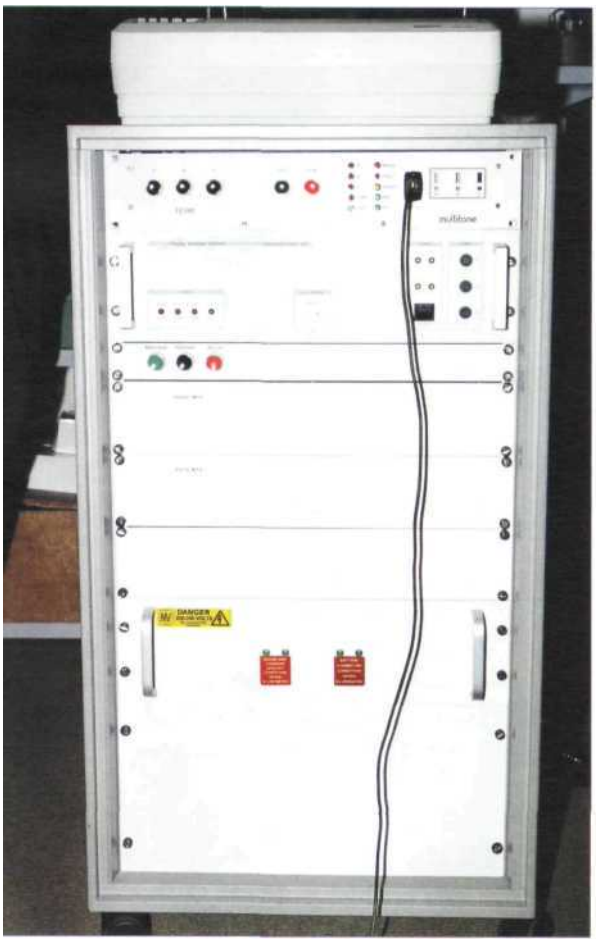


Figure 11.2 MG4 Alerter Transmitter combined with a GD/92 compliant 'Station end' mobilising terminal.

- Generates required team fire or test call using **POCSAG** paging protocol. (See Alerters) Up to 3 teams and the combinations of such are catered for.
- Generate paging calls with alpha numeric messaging if required for individual calls.
- Control the sending of calls via the transmitter and the monitoring of transmitter parameters during calls. (See Transmitter.)
- Record the operation of team 'off air' monitor receivers to determine the transmission of correct call data.
- Assemble the monitored transmitter parameters and the 'off air' receiver status and produce a message indicating a successful or

failed call and send this to the station GD92 Comms unit for onward transmission to control. If the call is a failure the type of failure is also returned.

- Provide a considerable degree of configuration in order to be able to replace a faulty encoder at a station with the minimum of delay.

- Where stations may overlap from the point of alerting coverage provision is made for coping with simultaneous mobilisation of the two stations.

It should be noted that although individual manufactures have to comply with the requirements of the MG4 specification they are not restricted from providing additional features, either, of their own idea or at the request of Brigades, subject to these not compromising the prime requirements. As these vary from manufacturer to manufacturer it is not intended to include these in this document.

11.3 Transmitter

The transmitter performs the following basic functions:

- As the paging code specified in MG4 is POCSAG (Post Office Code Standardisation Advisory Group) this requires the transmitter to use FSK modulation. The POCSAG code is referred to in a little more detail under Receivers.

- MG4 requires that a minimum of two transmitter parameters be monitored during a call namely forward power and reverse power.

- The transmitter must be capable of 25 watts output with the ability to set alarm trigger levels. As a guide a level of 12 watts (3 db down) would set the alarm. The reverse power alarm indicates the efficiency of the aerial and would normally trigger at what is termed a 'voltage standing wave ratio' of 2:1 or approximately 0% reduced power transmitted.

- The allocated frequency for Firefighters alerting is 147.8Mhz and used throughout the UK. A separate frequency allocated to Emergency Services is often used to provide wide area officer paging and on a few occasions has been used for mobilising purposes. This frequency is 153.05Mhz

11.4 Alerters

MG4 calls for the use of alerters working to the POCSAG format which are produced by virtually all manufacturers, and uses a 7 digit numeric address or **Ric** (**R**eceiver identity code) code.

The Home Office instituted a numbering scheme whereby the last three digits are fixed for each Brigade. The POCSAG code allows the first four digits to range from 0000 to 1999, a total of 2000 codes per Brigade. In the event of a Brigade requiring more Ric codes, if for instance multi-Ric code alerters are used for officer paging, then these are available on application to the Home Office. Two Ric codes are normally required for Firefighters alerters but versions with 4 codes are available.

Alerters need to be robust and have protection against ingress of moisture and dust. POCSAG pager design is driven by the large area wide paging market demands of companies such as BT and Vodapage together with other international service providers. Final design is, therefore, a compromise between design requirements, ready availability, and competitive pricing. This results in low cost units which are often cheaper to replace than repair.

Firefighters alerters are normally of the 'tone only' type although some have limited display options to highlight Fire or Test calls. A flashing LED operates on receipt of a call. The use of rechargeable batteries has virtually disappeared although still available. A limited need for intrinsically safe alerters exists, more from the point of view of equipping Firefighters with such units because of the hazardous areas in which they normally work rather than operational reasons. A vibrate option is available where the normal workplace is subject to high noise levels.

The Alerter is required to sound for a minimum of 30 seconds. POCSAG pagers vary in the period of

Figure 11.3 Alerter.

(Photo: Multitone)

call generated by receipt of a single call from an MG4 unit and multiple calls are often used to achieve the overall required alerting period. This has the advantage of increasing the chance of receiving a call as say four calls separated by 12 seconds improve the chances of receiving at least one good call in areas of weak coverage. Alerters are equipped with a call cancel button.

Chapter 12

Chapter 12 - Mobile Data

12.1 What is Data?

In data communications, information is transmitted in the form of characters, namely letters, figures, and symbols. The information is represented by binary signals, which are characterised by different states. When considered electrically, these signals correspond to, for example, tone ON, and tone OFF.

In digital message transmission over radio circuits, the signal elements of the characters are transmitted in turn (serially). Figure 12.1 shows the relationship between DC keying and VF keying.

The Fire Service has been using Data at incidents for many years in various formats. 'Data' can be interpreted as telemetry, resource updates, risk information, and can be deployed as direct links to command and control systems.

Data transmission capabilities and speeds (rates) are dependant largely on bandwidth. The bandwidth and, hence, capacity, has risen over the years and hence typical data rates now are around 9600 bits per second (bps), and with developing technology and compression techniques are expected to rise in the next few years.

Data can be sent both to and from vehicles and used to supplement information held onboard. The development of personal computers (PCs) and associated software/hardware now allow more data to be stored onboard vehicles.

12.2 History

Resource Availability Status (RAS)

The use of mobile data in the Fire Service began in the late 1970's when Resource Availability Status

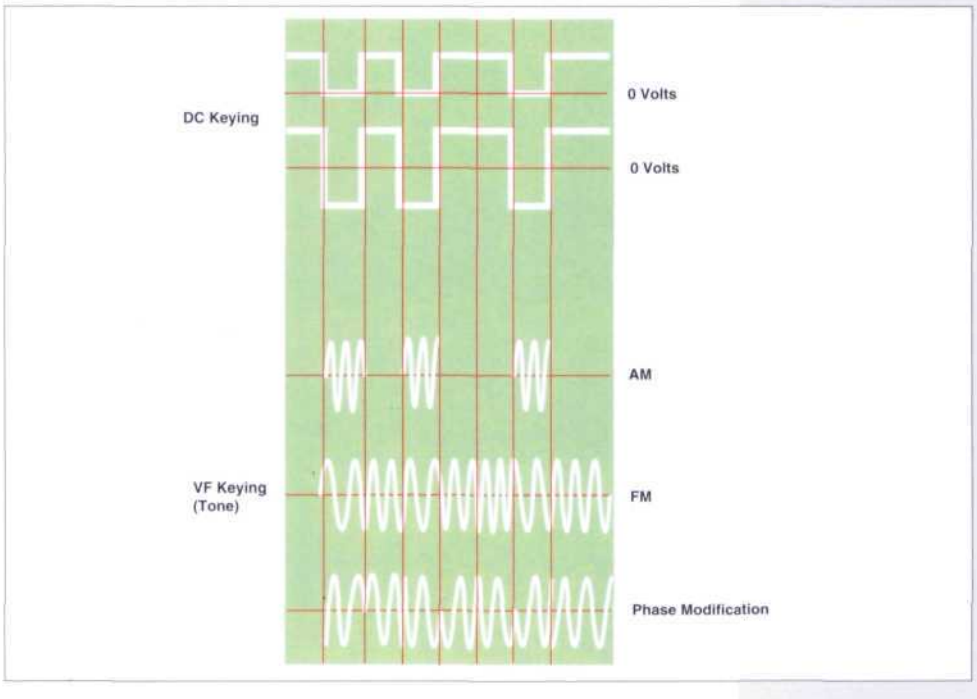


Figure 12.1 Relationship between DC Keying and VF Keying.

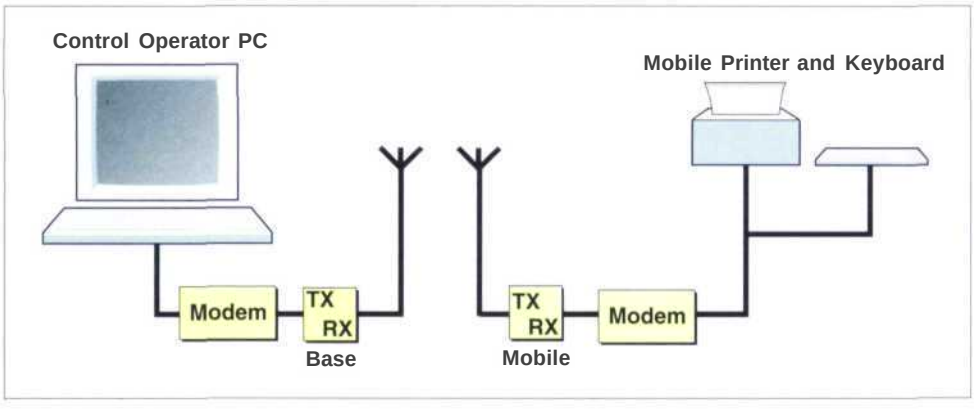


Figure 12.2 Typical data transmission arrangement.

(RAS) was incorporated into some existing radio systems. The first systems operated at 100 baud and were literally one way only with the acknowledgement being a single tone. Further development enabled these systems to operate at 300 baud with two way communications.

All systems operated over the speech radio network. One of the major problems associated with this shared voice/data radio channel was that data tones would block speech traffic using the radio channel. This had the effect of data being received but speech having to be re-transmitted.

Mobile Data

Depending upon the level of traffic, it is sometimes better to provided a radio channel specifically for mobile data. This allows a number of different types of messages to be passed. The first systems went live in 1989 providing a series of services to the incident. For example:

- Mobilising messages (C&C to mobile).
- Administrative messages (C&C to Mobile).
- RAS messages both directions.
- Access to Management Information Systems.
- Access to Chemdata central information.
- Incident messages (mobile to C&C).

This was the first time it was possible for mobile information to be directly input into C&C systems (RAS had been possible earlier) without any Fire Control personnel action and requiring the Control Room staff to change working procedures.

Figure 12.2 above shows a typical data transmission system. The Dispatcher computer interrogates the mobile to establish contact and on receipt of an acknowledgement, sends the data as a burst transmission. The mobile is able to display and/or print out the received message. The process can also work in reverse, with the mobile initiating the call.

12.3 Current Technology

The term 'mobile data' encompasses data sent when an appliance is mobilised, available en route to an incident, or available at an incident. Requirements for the provision of data vary from brigade to brigade leading to a multiplicity of system configuration. The main elements of these vehicle mounted systems are communications processors, visual displays, printers, keyboards, radio modems, etc.

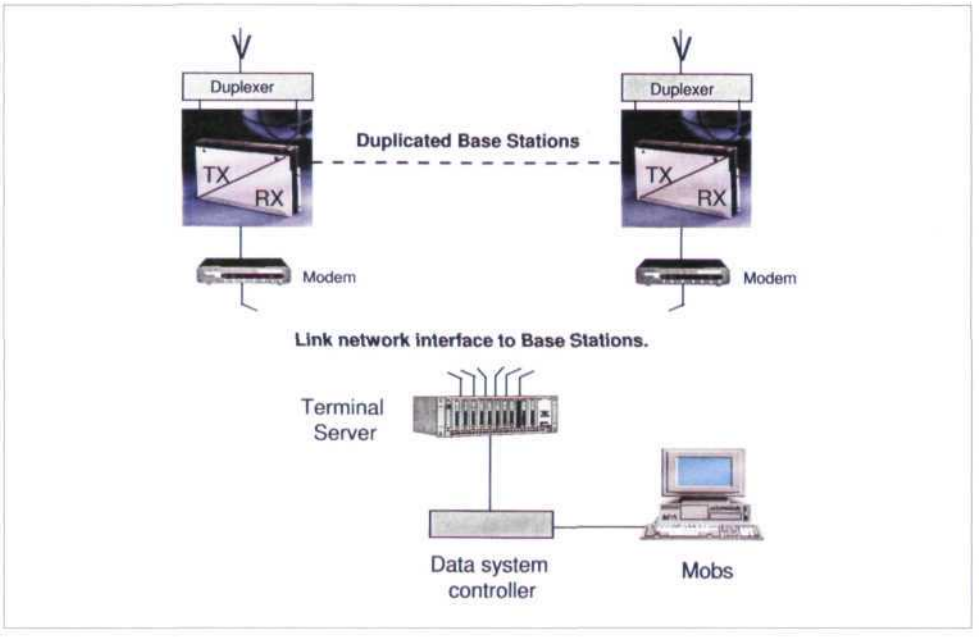
12.4 Radio Communications

Various options are available for the transmission of data between mobiles, or from mobiles and/or fixed locations.

Existing Brigade Radio Schemes - It is possible to transmit data over existing analogue radio schemes, in fact some brigades use this bearer as part of their mobilising arrangements. Typical transmission rates are 1200bps Frequency Fast Shift Keying (FFSK).

GSM Cellular Telephone - The Global Systems for Mobile Communications (GSM) networks

Figure 12 3 Data infrastructure.
(Graphic: Simoco)



Data Infrastructure

Figure 12.3 shows a typical data system infrastructure developed for use by UK Fire Services. Such a system is able to make use of the Fire Station mobilising system that already forms part of the Command and Control facility at any Fire Service Communications Control Centre. The mobilising system is connected to a Data System Controller whose purpose is to control the operation of the radio data system via the Terminal Server. One function of The Data System Controller is to transparently convert data into a form suitable for transmission to the hill top site Radio Modems. The Terminal Server distributes data to and collects data from the Radio Modems. 'Best hill-top site' information is stored and continually updated for all mobiles and the appropriate site used for any communication with a mobile.

It is possible to send general text messages between Control and mobiles as well as status messages from mobiles to Control.

incorporate both voice and data modes of operation. These networks consist of individual radio base stations that communicate with the users, each base station forming a cell. In the data mode the system offers a circuit switched, end to end communications service and, at present, transmission speeds of up to 9.6K bits per second.

Packet Radio Service - There are several commercial packet radio data networks. These networks deliver data in the form of bursts or packets. Each packet contains address information, information data and some form of error correction.

12.5 Data on Vehicles

The data available on mobile resources is as diverse as that held in the office environment. Individual brigade requirements vary from providing limited information held on mobile computers, to being able to access personnel records, building plans, status messaging, global positioning, updating the central mobilising system, receiving turnout information and chemical and risk data.

The data available must be current for it to be of value. The provision of many geographically scat-

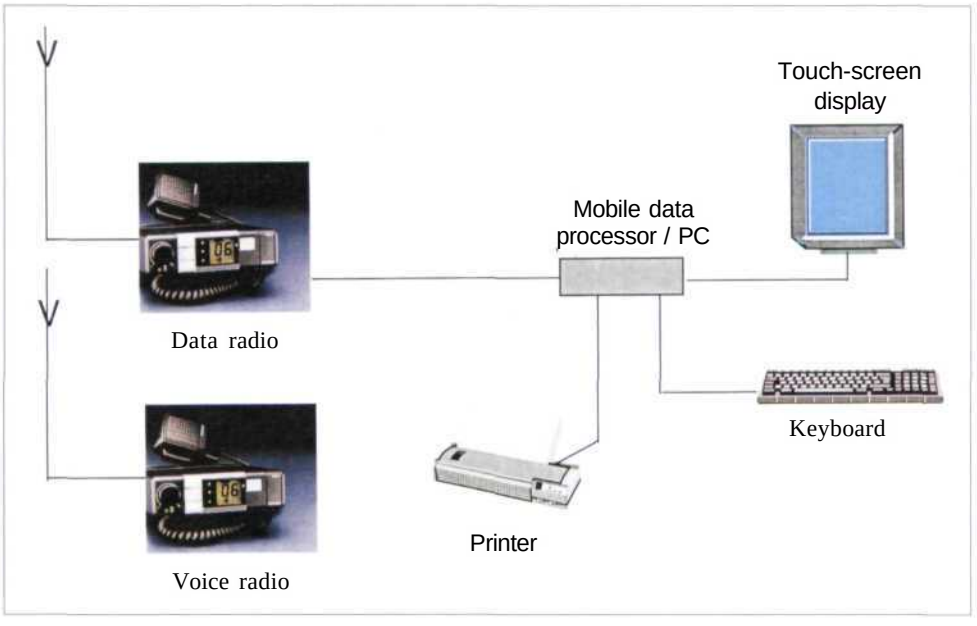


Figure 12.4 In Cab Equipment.
(Graphic: Simoco)

In Cab Equipment

Figure 12.4 shows the typical vehicle installation in a Fire Appliance. This comprises two separate mobile radios, including a Voice Radio which can be used for voice transmissions at any time and a separate Data Radio operating on its own radio channel.

The Data Radio, which would incorporate a modem, would be used to pass status information, various data, and free text information from a Mobile Data Terminal (MDT) which comprised an in-vehicle PC, Touchscreen Display, Printer and Keyboard. The PC might be equipped with large capacity hard drive memory which can hold map data, chemical data, risk files etc., which can be triggered by the incoming data to give information specific to the incident. The Touchscreen gives the mobile operator the facility of manually accessing data, maps etc. or of inputting status or text messages, as required.

The printer makes it possible to produce hard copy of diplaxed data, while the keyboard max be used for the inputting of text or for maintenance access.

tered mobile data terminals leads to difficulties in maintaining the data, especially if a large percentage is held on the terminal. It is essential that a robust and effective system is established so that updating the stored information is carried out on all the terminals within a minimum period of time

Part of this process should include an audit trail so that it is possible at a later stage to verify when and who amended any of the data files. Various methods have been adopted to carry out this procedure including updates by floppy disk, CD ROM, radio or wire connection to each data terminal when the vehicle is in the fire station.

12.6 Typical Data Requirements

The following data packages are available for use on mobile processors, whether held on the mobile, retrieved from a central source or a combination of both. Software licensing issues, along with other factors, may influence whether data is held centrally or dispersed amongst the mobile terminals.

1 Status Messaging

The ability of the mobile resource to update the central mobilising computer of any change of status instead of using a voice radio or cellular telephone scheme. This facility should also incorporate the ability to send other standard messages, for example, assistance and stop messages, and should have a free text option to cater for any non standard messages.

2 Risk Information

Information gained from the inspection of premises, under the relevant section of the Fire Service Act, shows the layout of the premises, the utility supply inlets and isolating points, the location of water supplies and any risks to fire fighting. This data, which has traditionally been held in paper form, lends itself to being held electronically, thus making it available to all mobile data terminals and centrally on the brigade's own network. Building plans and maps may also to be linked to this risk information.

3 Brigade Information

Brigade orders, fire fighting information, operational and technical procedures, any information produced by Brigades or from other sources may be held in an easily retrievable format so that the Officer-in-Charge of an operational incident has all the information available.

4 Hazardous Information

Information relating to hazardous substances may either be held on the mobile or centrally. Chemdata, for example, when held centrally, can be distributed by radio and only comprises of a relatively small amount of data.

5 Graphical Information Systems (GIS)

GIS software, which requires mapping data, gives the operational crews access to maps of the Brigade area, ranging from 1:50.000 raster based maps to vector based maps, which enable the operator to zoom in to display individual buildings. These maps can then be linked to building plans, street maps are also available to replace the map books carried on vehicles.

Hydrant and water main information may also be superimposed on the maps so that the information resources of the Brigade are available to all mobile terminals.

Clearly, mapping data files are quite large. Therefore, storing the maps centrally and transmitting the data on demand would require high transmission rates, cause congestion on the radio network and be expensive. Currently, it would be better to store this type of information on the mobile data terminal hard drive (if available).

6 Automatic Vehicle Locating Systems **(AVLS)**

AVL systems have been available commercially for some years. It has only been more recently that the Fire Service has investigated the technology for its own use (see DCOL 8/1997, in Scotland DFM 8/1997).

There are two basic systems in use; land based and satellite. The vehicle is fitted with a suitable AVLS receiver which, following the reception of signals, allows the geographic position to be computed and then transmitted to a central mobilising system. The position of the vehicle is then displayed on a map at the central control.

These systems have varying degrees of accuracy but care must be taken when attempting to predict the precise location and direction of movement of a vehicle using this system. It is possible for example, that the AVL system could indicate that a vehicle is located close to the scene but it transpires that it is on the wrong side of a river or motorway to attend the incident. (See AVLS, Chapter 7.)

7 Vehicle Telemetry

With the provision of a processor on a vehicle and a wireless connection with a central

point it is possible to send telemetry information. For example, information on the vehicle engine systems could be routed to the Brigade's transport department or show quantities of water, foam or other operational consumables to the Control Centre or mobile control unit.

12.7 Mobile Control Units

With the development of reliable data transmission technology and vehicle based computer systems, mobile control vehicles, used for major incident command and control, are now being equipped with IT systems linked to brigade computer networks and mobilising systems.

These vehicles include complex computer systems and voice/data message handling facilities. Bespoke software packages have been developed specifically for this purpose.

Chapter 13 - Breathing Apparatus Telemetry

There is an increasing need to provide firefighters, particularly those protected with breathing apparatus, with enhanced information to improve both their safety and operational effectiveness. This information could include, for example, information on remaining cylinder contents and respiration rates, ambient and body core temperature, heart-rates, etc.

This data can be displayed to the wearer in full, or more practicably in an abbreviated form, perhaps by means of a display in the firefighter's breathing apparatus facemask. They can also be recorded in an electronic data-base and downloaded at the conclusion of the incident, to provide a record which can be added to personnel records and used in the investigation of any injury or malfunction of the apparatus.

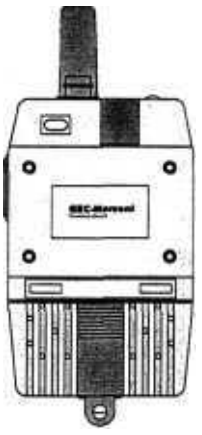
It is also possible to transmit some of this data by radio to those controlling the incident, including the Incident Commander or the breathing apparatus Entry Control Officer where the data can be used to provide information which can be used to facilitate better control of the incident and to improve firefighter safety.

The provision of a radio data link between firefighters and those controlling the incident will also permit the remote signalling of other safety signals, including the transmission of information to the breathing apparatus Entry Control Officer of a message in a data format indicating the automatic or manual operation of a breathing apparatus Distress Signal Unit, and the transmission of a message in a data format causing the operation of an Evacuation Signal either to all in the risk area or selectively.

It also facilitates the signalling of a radio message in a data format indicating that the operator is withdrawing from the risk area for reasons of personal safety. This last information, particularly if more than one team signals this, will assist the

Figure 13.1 Radio Distress Signalling Unit. *(Graphic: Marconi)*

Radio Distress Signalling Unit



- Functions as an Automatic Distress Signal Unit
- Intrinsically safe
- Transmits Distress Alarm message
- Transmits Withdraw message
- Receives Evacuation message
- Receives Selective Evacuation message
- Transmits Data from external source

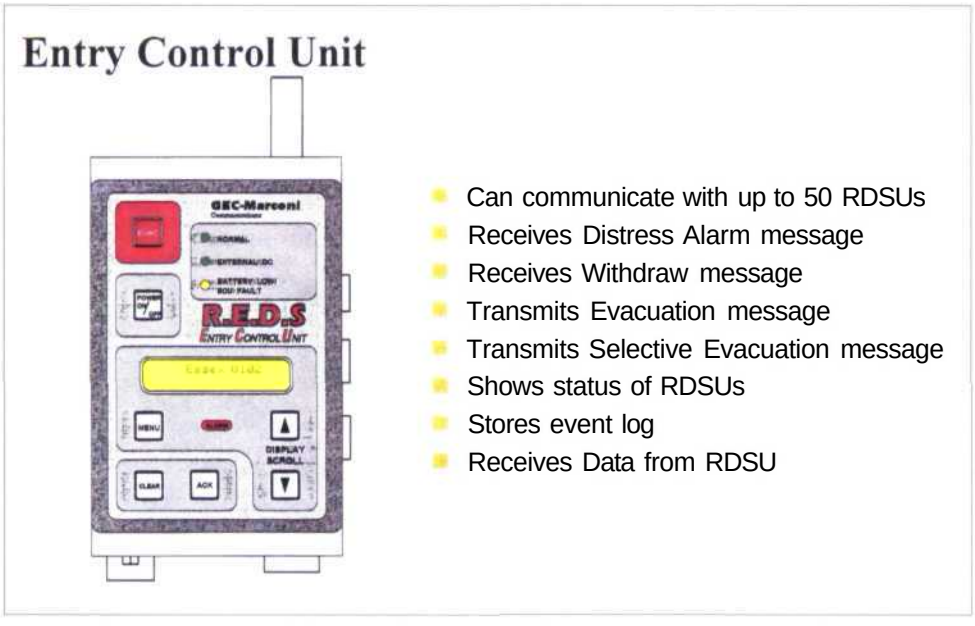


Figure 13.2 Entry Control Unit.
(Graphic: Marconi)

Figure 13.3 Telemetry in use during trials.
{Photo; Essex Fire and Rescue Service)

Incident Commander in deciding whether emergency evacuation of the risk area is justified.

The Home Office has developed a User Requirement (JCDD/40) for fire service telemetry based on the use of a dedicated radio frequency in Home Office regulated radio frequency bands, supported by a Type Approval (MG41) specification and a common-air interface.

Figure 13.4 Telemetry in use by Breathing Apparatus Entry Control Officer.

This User Requirement specifies the minimum functionality for such equipment, which includes remote signalling of Distress, remote signalling of Evacuation, Selective Evacuation, and signalling that the operator is withdrawing for reasons of personal safety. It allows the equipment to be combined with, and provide the functionality of, an Automatic Distress Signal Unit. It also allows connection by means of a standard interface, and transmission of data to and from operator-worn equipment providing enhanced functionality such as cylinder contents, temperature and so on. A similar connexion is specified for the remote element of the system to allow the use of equipment for managing the incoming data.

Chapter 14 - Sub-surface communications

Although there are exceptions, underground tunnels and similar structures are normally designed for use for transportation, mineral excavation, car-parking and storage purposes. Apart from underground car parks, the structures are often quite old and, as a result, neither designed or built to ideal standards.

The characteristics of each tunnel or structure will vary greatly, a tunnel may be nothing more than a short horizontal tube cutting through a hill, or it may be a vast underground complex with many tunnels, access points and service and customer facilities. Tunnels under construction will give rise to different problems.

The following applies to any building which is constructed completely or partially below ground, and includes any tunnel constructed as a railway, a roadway or for any other purpose that might attract a fire brigade attendance. It could include, for example, service access to large shopping, industrial, hospital, office and housing complexes.

For practical purposes there is no penetration of the surface by any of the radio frequencies used by the fire service for normal above-ground communications. Technical Bulletin 1/1993 provides guidance on Operational Incidents in Tunnels and underground structures and includes, as Part 3, Guidance on Communications in these risks.

In September 1997 the Home Office completed successful trials of a low-cost technique for improving fire service at-incident UHF radio communications. (Trial reports were issued in **DCOL 1/1998 Item C, in Scotland as DFM 2/1998 Item** C.)

The trial comprised a number of self-contained and handheld radio UHF base stations, operating on one of the UHF two-frequency 'simplex' incident channels on permanent talk-though, and used in conjunction with fire service standard handheld radios. Any number of such base stations can be linked together by means of a simple audio cable to provide seamless communications. In effect any handheld radio within range of one base station can communicate with any other handheld radio within range of any base station.

The distance between base stations is limited by the physical length of the connecting cable (100m in the trials) and by the maximum radio range achievable in the specific risk using UHF handheld radio radios.

Typical coverage using six base stations were:

1150m in a Railtrack tunnel (compared with 350m using a single base station). The limit in this case was the length of connecting cables.

810m in a BT cable tunnel (compared with 160m using a single base station).

The Home Office has produced a specification, **MG49,** for this type of equipment to enable brigades to carry out their own procurement.

In operational use, one base station might be established on the surface. A Breathing Apparatus team would then enter the risk area carrying one or more additional base stations and the associated connecting cables, deploying a connecting cable as they advance. The first base station automatically emits a repeated tone so that the BA team can discern when they reach the limit of radio coverage from that base station. At this point they can establish a second base station and connect it to the first base station thus providing

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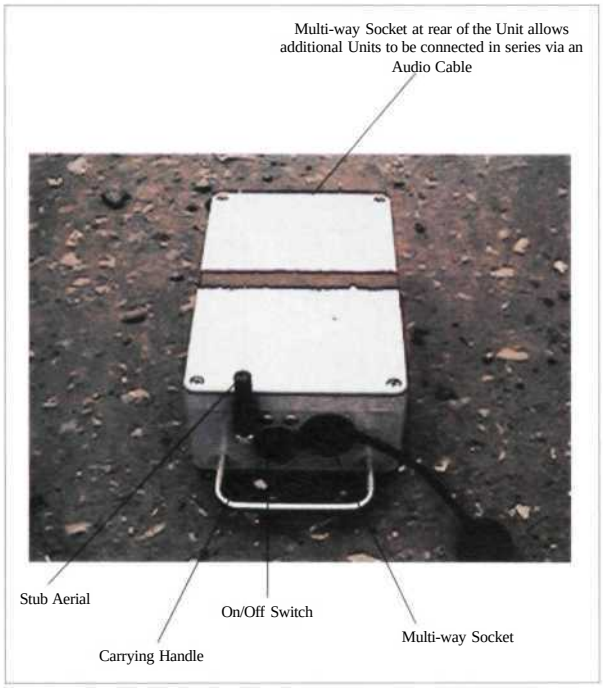
Multi-way Socket at rear of the Unit allows additional Units to be connected in series via an Audio Cable
Stub Aerial
On/Off Switch
Multi-way Socket
Carrying Handle

Figure 14.1 Home Office Repeater Unit.
(Photo: Devon Fire and Rescue Service)

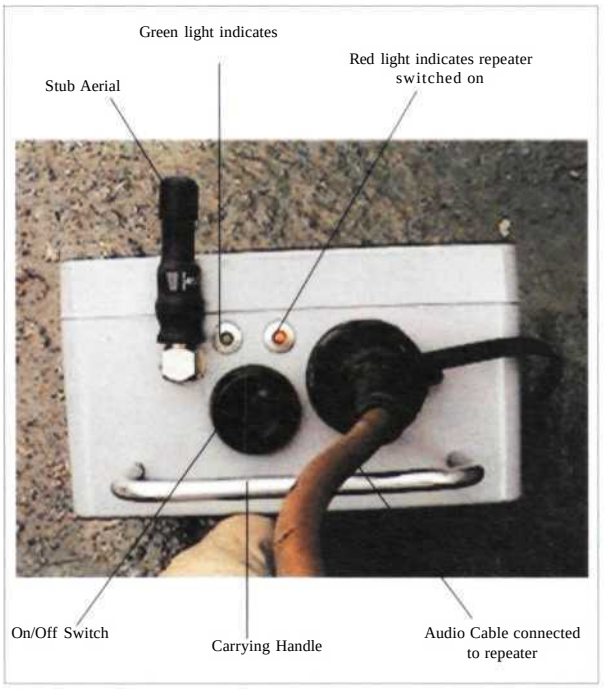

Figure 14.3 Home Office Repeater Unit.
(Photo: Devon Fire and Rescue Service)

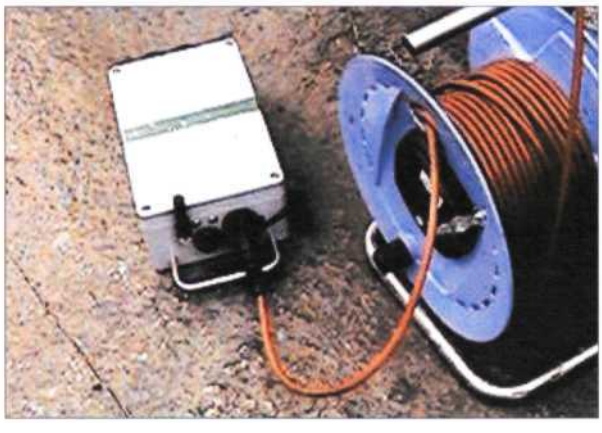

Figure 14.2 Home Office Repeater Unit.
(Photo: Devon Fire and Rescue Service)

Figure 14.4 Sonic UHF/UHF Repeater Unit.
{Photo: Devon Fire ami Rescue Service)

continuous coverage from the surface to beyond the second base station.

The team can then proceed further into the risk area, deploying further cables and base stations as necessary. Each base station would transmit a unique identity tone.

A technical disadvantage of this method of deploying the equipment is that it does not maximise the range achieved because it ignores the potential additional coverage which can be achieved when a second (or subsequent) base station is deployed, i.e., the second base station, once connected and activated, will provide its own coverage area. Using this method of deployment coverage will overlap that already achieved from the first base station. There is also the possibility of quasi-synchronous interference beats.

The foregoing arrangements can be improved by establishing 'ideal' locations for base stations as part of incident pre-planning. Connecting cables could be pre-laid and base stations could even be installed at appropriate risk sites.

Chapter 15

Chapter 15 - Potential hazards of using radio equipment

IN FLAMMABLE ATMOSPHERES NEAR EXPLOSIVES OR IN HOSPITALS

Special precautions are necessary when working in areas where a potential ignition or explosion hazard exists. These could be due to the presence of flammable dusts, gases or vapours, such as in oil refineries, petrol storage depots, some factories and commercial premises, coal mines, etc. The introduction of electrical or electronic equipment, such as a radio, by firefighters to such environments may constitute an ignition hazard.

Where such environments are known to exist, or are suspected, then the electrical equipment needs to be safe for such use. This means that such equipment should be designed in such a way that it does not present a hazard and that it should be certified accordingly. There are a number of design concepts for achieving this of which the most common for radio terminals is that of **'Intrinsic Safety'.** Any equipment designed to be safe in such environments is generically described as 'explosion protected'.

Additional precautions are also necessary when using radio transmitters in the vicinity of explosives, ignition hazards or other devices that may be adversely affected by radio transmissions. This section deals in some detail with the technical aspects of terminal equipment to be used in potentially flammable dusts, gases or vapours. It concludes by giving operational advice and guidance on precautions to be taken by firefighters when using radio transmitters in potentially flammable or explosive atmospheres and use of radio in the vicinity of explosives, petrol stations and medical devices.

15.1 Explosion Protection • Standards

In the European Union (ELI), standards for electrical equipment designed for use in flammable gases and vapours are those approved by the European Committee for Electrotechnical Standardisation (**CENELEC**). Such equipment may be certified as meeting the relevant standard by an EU approved Certification Body. The relevant EU standards for Intrinsic Safety are drawn from EN50 014, EN50 020 and EN50 039.

Terminal equipment in current use in the fire service may have been manufactured to comply with an earlier standard, e.g., British Standard 1259, 1958 or a BASEEFA standard SFA 3012 1972. This equipment can continue to be used **until** replaced.

Outside the EU other standards exist. In particular, in the USA and those parts of the world where US standards prevail, equipment is certified to standards specified by either Underwriters' Labaratories or Factory Mutual Research Corporation.

For the UK fire service the recommended standard for general applications where a potential ignition hazard exists is for equipment that is certified for use in Zone 1 with gas group IIC and a maximum temperature rating of T4. Such equipment would be indelibly marked EEx ib IIC T4 (or T5 or T6). It is also recommended that such equipment should satisfy a degree of ingress protection of at least IP54 to EN60 529.

It is recommended that radio equipment purchased for use with breathing apparatus should, as a minimum, conform to this standard. The equivalent US standards are Underwriters' Laboratories UL913 or Factory Mutual Class No 316.

15.2 Ignition Sources

The presence of radio terminal equipment in a potentially explosive, or flammable, dust, gas or vapour can give rise to a number of possible hazards from which ignition might result. These include overheating of the radio terminal during use or, more likely, during fault conditions. In modern mobile radio terminals from reputable manufacturers this is most unlikely to occur under any working conditions when the equipment is fully serviceable and operated correctly.

The other potential dangers from the use of radio terminal equipment arises from the possibility of sparking. Sparks of sufficient energy to cause ignition may be produced by two quite distinct mechanisms, as follows:

(1) Sparking may occur when contacts are made or broken in circuits carrying electric currents, or containing sources of electrical energy; and

(2) Whenever a radio transmission is made the electro-magnetic field radiates radio frequency voltages in all conducting materials in that field. The induced voltages in adjacent conducting elements, or between conducting elements and 'earthy' conductors, may be sufficient to break down intervening insulating layers of oxidation, grease, air, etc., and cause dangerous sparking. This hazard is directly related to the nature of the environment, the characteristics of the transmission (power, type of modulation, etc..) and the distance of the antenna from the hazard.

15.3 Protective Measures

Fire service mobile radio terminals (with an expected transmit power between 5 Watt and 25 Watt) potentially introduce all of the hazards described in paragraph 3 above into the risk environment. There is also a potential risk that the antenna of a vehicle mounted radio may directly touch a conductor during transmission causing sparks.

The design of such equipment precludes the adoption of any satisfactory explosion protection strategies and, therefore, such radio terminals must be regarded as a potential ignition risk when used in a potentially flammable or explosive dust, gas, or vapour.

When transmitting, they may also introduce a risk of inducing a current in a conductor, causing remote sparking and ignition or some other unwanted consequence.

The only practicable safeguards are to exclude the radio terminal (or the vehicle on which it is mounted) from the hazardous environment.

The risk from any 'fixed' mobile radio terminal equipment should be minimal since it is expected that any potential hazard should have already taken into consideration before siting is decided. However, some brigades employ transportable terminal equipment which may be used, for example, as temporary controls or talk-through stations for special purposes. Such terminal equipment generally has transmitter power of 5-25 Watts and, therefore, the potential risk is comparable to that of a vehicle installation but it may be used in locations inaccessible to vehicles. This category of equipment should not be overlooked in any hazard assessment or the drafting of relevant orders.

For relatively low-powered handheld radio terminal equipment (typically less than lWatt) the maximum radiated power is usually insufficient to create induced currents in adjacent conductors. Potential ignition hazards with handheld radio terminals are, therefore, limited to the development of dangerously high temperatures, and sparking caused by making or breaking electrical circuits. High temperatures are only likely to exist in fault conditions, e.g., by a component failure or breakdown of insulation and steps can be taken to prevent internal sparking that has sufficient energy to ignite a flammable or explosive dust, gas or vapour.

Thus, it is a practical proposition to design an handheld radio terminal which can be used with safety in a potentially hazardous environment, i.e., explosion protected equipment. Explosion protected terminal equipment nearly always exists as well in a normal, un-protected form. In comparison with the non-protected terminal equipment the protected equipment will often have a reduced maximum transmitter power, be more expensive to procure and maintain, will require 'special' batteries and may have reduced functionality.

The selection of protected types of handheld radio is also likely to be much less than un-protected types and purchasers may have a limited choice of equipment from which to select equipment for procurement.

15.4 Intrinsically Safe Design Criteria

The requirement for explosion protected equipment certified for use in flammable, or explosive dusts, gases or vapours, means that the equipment must be incapable of causing ignition, even under fault conditions or when subjected to gross mishandling. This necessitates design features which often have performance penalties in normal conditions.

It is usually necessary, for example, to make it impossible for batteries to be fitted or removed within the hazard area, because of the potential danger of sparking during this process. Therefore, it is usual for the battery compartment of such equipment to be fitted with a key-operated lock so that compartment can be locked and the key retained outside the hazard area. In ordinary fire brigade use such a fitting may be an inconvenience.

To obviate the possibility of components overheating, current limited devices (often resistors) have to be fitted which may reduce performance. Extra thermal insulation may have to be provided, making the equipment more bulky than it would otherwise have been. The mandatory distance separations of components, and conductors on printed circuit boards, may also affect equipment size.

Requirements for special materials or plating, necessary to withstand long-term exposure to certain chemicals, involve considerable additional cost; as does the incorporation of all the other non-standard requirements mentioned. These are some of the factors which combine to make the idea of using this equipment for all purposes quite unattractive both from size and costs.

15.5 Selection of Explosion Protected Equipment

The current recommendation to the fire service is that radio equipment purchased for use with breathing apparatus should be certified by an EU approved Certification Body for use in Zone 1 with gas group IIC and a minimum temperature rating of T4. Such equipment will be indelibly marked as follows:

EEx ib IIC T4 (or T5 or T6)

Certified equipment must cater for worst-case conditions for the whole of its working life under continuous operation in a hazardous environment. It must also take into account carelessness, clumsiness and ignorance on the part of the operator.

In perspective, the few occasions when faults will develop in modern personal radio sets are considered and the fact that fire service personnel are trained to comply with instructions regarding care of this equipment, the occasions when all the above special design features would be needed is small.

15.6 Radio Use in the Vicinity of Explosives, etc.

Radio transmissions impose a potential ignition or initiation hazard near commercial explosives, military ordnance (including nuclear weapons) and terrorist devices.

Current guidance to the fire and police services is that no radio transmitting equipment should be used within 10m of the risk, that only handheld terminal equipment (less than 5 Watt) should be used within 10m and 50 metres, and that vehicles fitted with mobile radio terminals should not be taken within 50m of the risk unless the radio is switched off.

In this context, many modern radio terminals,for example, data capable radios, 'trunked' radios and radios using public cellular or public data services are capable of auto-transmission. Unless the transmission function can be inhibited by the user such equipment should be switched off if it is necessary to take it into the protected area appropriate for the type, e.g., if it is necessary to take a public cellular radio terminal to within 10m of the hazard.

15.7 Radio Use in Vicinity of Retail Petrol Stations, etc.

Current guidance to the fire and police services is that similar restrictions to those applicable to the use of radio terminals in the vicinity of explosives should be applied in respect of retail petrol stations, petroleum transfer stations and oil depots.

15.8 Radio Use in the Vicinity of Air Bags

Because of the potential, but remote, danger of actuating an air bag in a vehicle which has been involved in a road traffic accident in which an air bag has not actuated, no radio terminal should be used to transmit a message within 10m of the vehicle.

Additionally, to avoid the remote possibility of unwanted actuation, no handheld radio terminal or handheld cellular radio terminal should be used inside a vehicle equipped with an airbag unless it is connected to an aerial system external to the vehicle.

15.9 Radio Use in the Vicinity of Medical Devices

There is a potential hazard that radio transmissions may have unwanted effects of medical devices.

No fire service handheld radio can be considered as being safe to use in radio sensitive areas of hospitals, nor can any 'safe-distance' be recommended. Accordingly, handheld radios should only be used for transmission in hospital buildings in exceptional circumstances and where the circumstances are unavoidable. If a handportable radio has been used then this should be reported locally to the hospital/medical staff so that they can initiate whatever checks they might think necessary to detect and rectify any effect that the transmission might have had.

In this context, many modern radio terminals, for example, data capable radios, 'trunked' radios and radios using public cellular or public data services are capable of auto-transmission. Unless the transmission function can be inhibited by the user, such equipment should be switched off if it is necessary to take it into a hospital premises.

Where a hospital has placed a restriction on the public use of cellular radios then these restrictions should also be taken as applying to handportable radio terminals or any public cellular radio terminals that may be used by firefighters.

15.10 Radio Use within Silos

The presence of a radio may cause ignition of any flammable dust, gas or vapour that exists in a silo. There is also a remote possibility that a transmission from a handheld explosion protected (intrinsically safe) may result in a spark caused by an inducedcurrent.

Accordingly, similar restrictions to those applicable to the use of radio terminals in the vicinity of explosives should apply to the use of radios near or within silos until it has been established by monitoring that there is no trace of a potentially flammable dust, gas or vapour within the silo.

Notwithstanding the foregoing, the Officer-in-Charge may decide to permit the limited use of explosion protected (intrinsically safe) handheld radios or telemetry equipment within a silo, provided that a risk assessment has been carried out and it is considered that the operational and safety benefits of so doing exceed the remote risk of ignition.

Glossary of terms and abbreviations

Address Point	Ordnance Survey digitally co-ordinated postal address data.
Alerter system	A call-out system utilising pocket-alerters, carried by retained firefighters, which are triggered by a radio signal transmitted by a remotely controlled alerter transmitter usually located at a fire station.
Algorithm	A procedural model used when computing complicated calculations (e.g., routes and drive times).
Analogue	An analogue signal is one which can vary continuously, taking any value between certain limits. The human voice, for which the public telephone network was designed, is an analogue signal varying in frequency and volume.
ACD	Automatic Call Distribution.
AFA	Automatic Fire Alarm.
AVLS	Automatic Vehicle Location Systems.
BA Interface	An interface designed to permit a handheld radio set to be used in conjunction with breathing apparatus.
Bandwidth	The range of signal frequencies which can be carried by a communications channel subject to specified conditions of signal loss or distortion.
Base Station	The transmitter/receiver and associated equipment at a fixed location.
CACFOA	Chief and Assistant Chief Fire Officer's Association.
Call sign	An identifier, normally comprising a name, numbers or letters, by which an appliance or officer is identified when being called by radio.
CCTV	Closed Circuit Television.
Cellular	A technique used in mobile radio telephony to use the same radio spectrum many times in one network. Low power radio transmitters are used to cover a limited area or 'cell' so that frequencies in use can be re-used in other parts of the network.

CHEMET	Chemical Meteorology.
CIMAH	**C**hemical **I**ncident **M**ajor **A**ccident **H**azard.
CLI	**C**alling **L**ine **I**dentity.
Concentrator	Any communications device that allows a shared transmission medium to accommodate more data sources than there are channels currently available within the transmission medium.
COSHH	**C**ontrol **o**f **S**ubstances **H**azardous to **H**ealth.
CTCSS	**C**ontinuous **T**one **C**ontrolled **S**ignalling **S**ystem. In PMR, a method of using sub-audio tones to effect selective transmissions to a mobile or group of mobiles.
Cycle	The portion of the radio wave between successive crests or troughs, which is repeated over and over again to form the continuous wave.
DCOL	**D**ear **C**hief **O**fficer's **L**etter.
DDI	**D**irect **D**ial **I**n.
DIEL	OFTEL's advisory committee on telecommunications for **D**isabled and **E**lderly People.
Digital	Communications procedures, techniques and equipment where information is encoded as either a binary ' 1' or '0'.
Digital data network	A network specifically designed for the transmission of data, wherever possible, in digital form.
DTI	**D**epartment of **T**rade and **I**ndustry.
Duplex working	A communications technique in which it is possible to transmit and receive simultaneously e.g., as in an ordinary telephone conversation.
EAs	**E**mergency **A**uthorities.
EACC	**E**mergency **A**uthority **C**ontrol **C**entre.
ERP	**E**ffective **R**adiated **P**ower.
ESM	**E**mergency **S**ervices **M**anager.
ETD	**E**xtension **T**runk **D**ialling **N**etwork.
ETSI	**E**uropean **T**elecommunication **S**tandards Institute.
Fire alarm call point	A device to operate the fire alarm system manually.

Fire alarm system	A fire alarm system comprising components for automatically detecting fire initiating an alarm of fire and taking other action as arranged. The system may also include manual call points.
Frequency	The number of cycles of wavelengths, which appear to pass a given point in a specified time, usually one second.
FFSK	**F**requency **F**ast **S**hift **K**eying.
FMG	**F**requency **M**anagement **G**roup.
FRNT	Front Office Directory.
Geocode	Assignment of a specific grid reference to an incident, address or rendezvous point, etc.
GIS	**G**raphical **I**nformation **S**ystems.
GPO	**G**eneral **P**ost **Of**fice.
GPS	**G**lobal **P**ositioning **S**ystem - Navigation system developed by the United States Defence Department as a world-wide navigation and position resource for both military and civilian use. It is based on a constellation of twenty four satellites orbiting the earth at a height of over 20,000 kilometres. These satellites provide accurate three dimensional position and velocity as well as precise time, and act as reference points from which receivers on the ground triangulate their position.
GSM	**G**lobal **S**ystems for **M**obile communications - European standard for digital cellular networks operating at 900 MHz world-wide and supporting data transmission.
GTPS	**G**overnment **T**elephone **P**reference **S**cheme.
Handshake	A predefined exchange of signals or control characters between two devices that sets up the conditions for data transfer or transmission.
Hertz (Hz)	Measurement of frequency where one Hertz equals one cycle per second.
Hilltop Sites	Or **Main Stations**are normally on high, open ground (hence the alternative name) from which it is possible to 'see', in the radio context, a considerable portion of the brigade area. 'Main' equipment operates in an 'omni-directional' mode to cover the largest possible geographical area.
HOFMG	**H**ome **O**ffice **F**requency **M**anagement **G**roup.
ICCS	**I**ntegrated **C**ommunications **C**ontrol **S**ystem.
ICU	**I**ncident **C**ontrol **U**nit.
Inmarsat	**I**nternational **M**aritime **S**atellite Organisation.

Interface	A shared boundary, a physical point of demarcation, between two devices where the electrical signals, connectors, timing and 'handshaking' are defined. The procedures, codes and protocols that enable two entities to interact for the meaningful exchange of information.
IS	**I**ntrinsically **S**afe Equipment designed to be operated safely in an environment consisting of flammable or explosive dusts, gases or vapours.
ISDN	**I**ntegrated **S**ervices **D**igital **N**etwork - An internationally agreed public network offering switched end-to-end digital services for voice and data.
KiloStream	The registered trademark for BT's digital network services, used for connecting a variety of high-speed applications including computers, LAN interconnect and switchboards.
LAN	**L**ocal **A**rea **N**etwork is one which spans a limited geographical area, usually within one building or site, and interconnects a variety of computers and terminals, usually at very high data rates.
Leakv feeder	A linear aerial which radiates radio signals throughout its length. Such an aerial is particularly suited to facilitating radio communications in sub-surface premises in conjunction with a UHF base station.
Link Transmitters	And **Link Receivers**provide communication between the control station and the main stations. '**Link**'equipment operates in a '**Point-To-Point**' mode in which every effort is made to send signals only in the intended direction and only so far as necessary.
Main scheme radio	A radio system giving wide area radio coverage throughout the area covered by the mobilising control.
Main Control	'Control Station' or simply 'Control'. This is the place where the operators who control the scheme, and the main transmitting and receiving equipment of a scheme are located.
Main Transmitters	And **Main Receivers**send radio signals to, and receive radio signals from 'mobiles'.
'Mobiles'	Are the transmitter/ receivers fitted in fire appliances and other vehicles.
MIS	**M**anagement **I**nformation **S**ystems.
MMC	**M**onopolies and **M**ergers Commission.
Modem	**M**odulator/**D**emodulator - device for converting analogue signals into digital signals and vice-versa.
Multi-station scheme	A scheme served by several main stations e.g., a large country scheme.
NOU	**N**etwork **O**perations **U**nit.

OAC	**O**perator **A**ssistance **C**entre.
OFTEL	Office of Fair Trading for Telecommunications.
Out-stations	All radio stations in a scheme, including two-way fixed and mobile sets and fixed receivers but excluding main stations, main and sub-controls.
PABX	**P**rivate **A**utomatic **B**ranch **E**xchange.
PCNs	**P**ersonal **C**ommunications **N**etworks.
PCS	**P**ersonal **C**ommunications **S**ystems.
PDA	**P**re-**D**etermined **A**ttendance.
PECS	**P**ublic **E**mergency **C**all **S**ervice.
PMR	**P**rivate **M**obile **Ra**dio - A network developed for one particular organisation, usually an emergency service.
POCSAG	**P**ost **O**ffice **C**ode **S**tandard **A**dvisory **G**roup
Private wire circuit	A dedicated telephone circuit permanently connected between two or more points for transmission and reception of speech and/or data.
Protocol	A set of rules governing information flow in a communication system.
PSTN	**P**ublic **S**witched **T**elephone **N**etwork.
PTO	**P**ublic **T**elecommunications **O**perator.
Public Address	A loudspeaker system which may be operated by remote control from a central control room or locally for both operational and administrative purposes.
PWIT	**P**ublic **W**arning and **I**nformation by **T**elephone.
RBRT	**R**acal **BR T**elecoms **L**td.
RIC	**R**eceiver **I**dendity **C**ode.
RIDDOR	**R**eporting of **I**njuries, **D**iseases and **D**angerous **O**ccurrences.
RFCPU	**R**adio **F**requency and **C**ommunications **P**lanning **U**nit.
Roamer	Is the term used to describe a person who takes their mobile phone abroad with the specific purpose of making or receiving calls.
Roaming	Is is the term used to describe the ability for a person to take their mobile phone abroad and be able to make and receive calls in a country with which their own network operator has signed a roaming agreement.

Running call facility	A facility at a fire station which enables a running caller to give an alarm of fire.
Secondary Control	A mobilising control (possibly in another fire brigade area) to which, in an emergency, the functions of receiving emergency calls and mobilising appliances are passed, in the event of an evacuation of the normal mobilising control.
Simplex working	A communication technique in which it is not possible to transmit and receive simultaneously.
Single frequency scheme	A scheme using one common frequency for transmitting and receiving by all stations.
SMS	**S**hort **M**essage **S**ervice.
Switch	A switch is the core element of a radio or telephone system. It provides control, management and the routing of voice and/or data calls between radio system infrastructure, mobiles and portables, telephones, controllers and computer terminals.
Talk-through	A facility on two-frequency radio schemes which interconnects incoming and outgoing channels. Used to enable out-stations on a scheme to hear and talk to each other.
Telemetry	A means of establishing measurement remotely.
Terminal	A device for sending and/or receiving data on a communication channel.
TODS	**T**elephone **O**perator's **D**irectory **S**ystem.
TOPS	**T**otal **O**perations **P**rocessing **S**ystem.
Transportable Radio	A portable transmitter/receiver of roughly the same power as a mobile set.
TUES	**T**ext **U**ser's **E**mergency **S**ervice.
Two-frequency operation	A means of operation whereby radios receive on one frequency and transmit on a different frequency (also known as double-frequency peration).
UHF base station	A radio installation which allows boosted signals of double frequency operation with UHF equipment. This equipment is usually provided as a mobile version but. exceptionally, e.g., at major airports, there are authorised fixed installations.
WAN	**W**ide **A**rea **N**etwork - Interconnects geographically remote sites.
WARC	**W**orld **A**dministration **R**adio **C**onference.
Wavelength	The distance between successive crests, or successive troughs.

Control Staff - Training, Competence and Promotion

Fire Authorities have a legal duty to ensure personnel are adequately trained. The Fire Services Act of 1947 Section 1(1) states "Every Fire Authority shall secure... the efficient training of the members of the Fire Brigade".

Training should be appropriate to the position held and must develop and consolidate the skills, knowledge and attitude of personnel to allow them to deal with a wide range of situations both efficiently and safely.

The ever increasing number of emergency calls, and increased managerial controls, have created greater training needs, not only for operational firefighters but also for Control Personnel.

The need for this training can be broken down **into:**

- Training required to maintain the operational effectiveness of Control Centre Personnel.
- Training recommended by the Home Office.
- Training essential to fulfil responsibilities in respect of legislation i.e.. Health and Safety, Equal Opportunities.
- Training desirable to enhance the professionalism of Fire Brigade personnel.

The combination of these four areas generate the requirements for training throughout the Brigade. The following strategy identifies all training requirements and sets out the provisions and guidelines to comply with these requirements.

Through training of personnel, the Brigade will respond to the needs of those it serves by defining training needs and providing the most effective means of fulfilling those needs, thereby providing a quality service.

Training for control personnel has always been hindered by the small numbers of staff available, and the need to maintain cover in the Control Centre. Training is usually watch related and carried out at the normal place of work, this ensures the maximum number of personnel available. For these reasons Brigades should consider the provision of a Training Officer, and/or Watch training days away from control.

Operator Training should ensure that potential problems for the Operator are kept to a minimum, the emphasis on call-handling training needs to address primarily the issue of how to handle an individual caller and what precisely to say to callers, especially those who appear to be in danger.

At all times the operator must:

- Listen - do not make assumptions.
- Be firm but polite.
- Be in control - interrupt callers if necessary to ask questions.
- Keep questions simple and unambiguous.
- Repeat address details to confirm they are correct - care should be taken not to do this 'parrot fashion' or at the same speed as typing. This sounds very inefficient and does not inspire confidence.
- Reassure the caller when necessary but do not state that the Fire Brigade is 'on the way' until sufficient information has been obtained

for crews to locate the incident. Informing a caller that appliances are en route may prompt them to hang up prematurely and result in a delay locating the incident.

- Remain calm, do not reflect panic or anger.
- Keep the tone of voice normal, even if having to speak louder.
- Speak clearly.
- Be prepared to rephrase questions to obtain details.
- Do not use Fire Brigade terminology.
- Do not hesitate, or tell the caller to 'hold on' or'bear with me' or use any other phrases or slang that may indicate lack of confidence or not being in control of the situation.

The techniques involved can be broadly categorised as 'reactive' or 'pro-active'. The operator can be entirely reactive if the caller provides the necessary information in the correct order and without prompting.

What is much more likely is that the caller will at the very least need to be prompted, particularly to provide the required information in the order needed to complete the call taking screen-format. Such an approach is both reactive because it responds to the caller and pro-active in the sense that it takes some measure of control over the human interface.

Where the caller is in danger, however, there may be a need to adopt a fully pro-active technique by:

- Providing relevant fire safety advice aimed at minimising the hazard to the caller; and
- Providing reassurance to the caller.

Fire Control Operators should have some basic knowledge of fire survival techniques. The first priority must always be the mobilisation of appliances followed by the standard fire safety advice -

"GET OUT AND STAY OUT".

Only when the caller or the situation clearly requires further intervention by the Operator to enable survival should additional guidance be offered. This guidance should be limited to standard fire survival advice suitably adapted to the situation, following an assessment based on information obtained from the caller.

The details obtained from a caller have to be as informative as is necessary to enable crews to locate incidents as quickly as possible. A few extra seconds questioning the caller may save minutes in actually locating the incident.

Full guidance on 'Training in Emergency Call Handling Techniques and Fire Survival Guidance' is contained in the Fire Control Personnel Training package issued to complement Fire Service Circular 10/1993.

Training recommended by the Home Office is promulgated to brigades through courses at the Fire Service College or as Fire Service Circulars, which recommend a framework from which individual fire authorities can compile their own training programme.

Many of the recommendations in FSC 2/1987 remain valid. However, further (and updated) recommendations are made in FSC 10/1993.

Fire Service College Courses

(Photo: HM Fire Service Inspectorate)

Currently there are three courses specifically focused on Control Personnel.

The needs of individual fire brigades will be taken into account when selecting candidates for courses at the Fire Service College.

Junior Control Room Course

- Operators who through appraisal have been identified as benefiting from attendance.
- Operators who have passed an internal promotion examination to Leading Fire Control Operator.
- Leading Fire Control Operators and Senior Fire Control Operators who have not previously attended the course.

Senior Control Room Course

- Leading Fire Control Operators who have successfully completed the Junior Control Room Course.
- Leading Fire Control Operators who have passed an internal promotion examination to Senior Fire Control Operator.
- Leading Fire Control Operators, Senior Fire Control Operators and Fire Control Officers who have successfully completed a Junior Control Room course, preferably within one year of promotion.

Control Management Course

- Fire Control Officers or their deputies who have, or may have, responsibility for running the brigade Control Centre, who have successfully completed a Senior Control Room course.

Refresher training

- Refresher training may also be available for personnel who have not attended a course at the Fire Service College for five years.

Brigade Based Initial Recruit Training

All recruits should be given a one or two day induction course which should include information on Health & Safety, Equal Opportunities, Representative Bodies, sickness reporting and leave entitlement. This is followed by a training course lasting a minimum of three weeks which may consist of classroom day duties. During training the recruit should be considered non-operational.

The recruit should be issued with training notes for guidance, and the use of personal training records is recommended. On completion of the course the probationary Control Operator must be able to demonstrate possession of the following core skills.

A basic knowledge:

- of the correct use of items of equipment in use within the Control Centre including call handling, mobilising, message and radio facilities;
- of the information required from emergency callers;
- of mobilising requirements for types of incidents;
- of the Fire Services Acts 1947 and 1959; Sections 1,2, 12, 30, and 31; and
- of completing incident statistics.

A working knowledge:

- of all callsigns and locations of mobile resources within the Brigade;
- of the methods of alerting resources and mobilising to an incident;
- of the Fire Service (Discipline) Regulations 1985 and the ability to respond positively in a disciplined environment; and
- **the ability** to understand, implement and represent the Brigade's equal opportunities policy in all dealings with members of the public and employees of the Brigade.

The probationary period may differ from brigade to brigade but, on completion, it is recommended that a final interview be held to discuss performance and career development.

After the recruit has been attached to a Watch, Continuation Training should be carried out progressively with the aim of improving skills and knowledge gradually. This may take the form of 'Competency based' training.

Fire Control Operators should be tested at various stages of their employment.

Training should continue until, in the third year, Operators consolidate the training received during, and since, the completion of their probationary period to prepare them for the Fire Control Operator's Qualifying Test.

The test, taken after completion of between 3 to 4 years service, should comprise three parts - oral, written and practical, the details of which are in FSC 10/1993.

A fully qualified Fire Control Operator should demonstrate the following skills

- All core skills as detailed in recruit fire control operator; and

A working knowledge:

- of all mobilising procedures at all incidents, and the ability to apply them;
- of advice to give to callers in emergency situations;
- of specialised mobilising procedures applicable to the brigade e.g..
  - Cave, mine and pothole incidents
  - Tunnels
  - Spate conditions
  - Fires at sea
  - Incidents involving cylinders
- of the location, and mobilising procedures, for all Fire Brigade equipment and appliances, and the location of neighbouring stations;
- of topography throughout the Brigade area including special risks;
- of initiating appliance standby moves when directed to do so by the OiC;
- of chemical retrieval systems and the passing of chemical information to crews at the scene of an incident;
- of the Central Risk Register and its uses;
- of the use of special appliances throughout the Brigade;
- of the construction, correct use, maintenance and standard tests off all items of equipment in use within the Control Centre;
- of all control 'fallback' procedures including secondary control;
- of fault reporting procedures and recording and amendments to fault records;
- of Health and Safety legislation particularly: COSHH, NAMOS, CIMAH, RIDDOR, especially where they effect Fire Brigade operational or control personnel;
- of accident/injury reports completed by control;
- of the Fire Services Act 1947/1959, Sections 2 and 12;
- of Conditions of Service with special reference to:
  - Leave Entitlement
  - Sickness Procedure
  - Duty Systems
  - Detached Duty Procedure
  - Grievance Procedure
- of the word processor and other software programs in use and the completion and distribution of MIS reports, where applicable;
- of the Brigade administrative procedures, control records and filing systems;
- of the control business plan and the Brigade plan, where applicable;
- of stores requisitions and goods/services received.

A **comprehensive knowledge** of Brigade organisation, including:

Brigade line of command
Brigade/Divisional organisation
Control management and responsibilities
Support services.

- of completing incident statistics; and
- **the ability** to complete project work and individual administrative references as detailed by the Watch Officer having received specific tuition as required.

As the operator progresses through the ranks many other skills are required.

(See core skills in **Fire Control Centres** section.) Some examples of these are listed below.

Officers should show the ability to:

- fulfil all obligations appropriate to rank and position;
- supervise and assist control operators;
- impart knowledge to others;
- apply the Fire Service (Discipline) Regulations 1985 as a Supervisory Officer;
- apply conditions of service including welfare and health & safety as a Supervisory Officer;
- communicate effectively;
- design, programme, run and monitor effective training programmes commensurate with Brigade policies, procedures and standards;
- give effective support and guidance to Watch personnel in career development;
- give effective support to the Watch Officer; and
- undertake watch reference administration duties which may include the following:

Command and Control budgets
Training records, schedules and information
Statistics
Supplies
Central Risk Register/database.

Officers should have a working knowledge of the following:

- good leadership practices in relation to the supervision of personnel and support of management;
- the financial implications of management decisions made at watch level;
- the financial implications of management decisions made at Control level; and
- theoretical and practical aspects of personnel motivation and welfare.

Watch Refresher Training

In addition to the basic core skills training all Control Personnel should undergo continuous on-watch refresher training. This training will be carried out on a systematic basis, both scheduled and monitored. The subject matter will depend on local circumstances with emphasis being placed on little used procedures.

Familiarisation Training

Control Personnel returning from absence through sickness, injury or maternity leave of three months or more should undertake familiarisation training to update them on Brigade procedures and to ensure the individual's competence in carrying out the core tasks.

Appointment and Promotion of Control Personnel

The Fire Service Appointments and Promotion Regulations (SI 1991/369) do not apply to personnel who are recruited specifically for control centre work. At present, standards for appointments and promotion for these staff are matters for individual fire authorities. On applying for a position as a Fire Control Operator, prospective recruits are

generally required to pass an elementary educational test set by the fire authority. If successful, the candidate will attend an interview followed by a medical examination.

Promotion is by selection with most local fire authorities establishing their own standards and promotion examinations for the purpose. Career development prospects for control personnel are necessarily limited because they are employed in relatively small numbers.

To determine the qualities needed as to the suitability for promotion to higher ranks prospective members of staff should receive personal development training. This training is normally carried out by individual fire authorities or centrally at the Fire Service College as part of a national syllabus for the more senior posts.

Standards of Competence

A Strategic Document on Standards of Competence for Control Centre Staff was issued to Brigades in October 1997.

Standards of Competence were produced by a steering group comprising of experienced control personnel and drawn from brigades representing the variations of size, risks, geographical make up, etc., in the UK. The Standards of Competence should be used by all control staff to evaluate their own performance and to identify personal development needs.

The Standards of Competence were accredited by the National Council for Vocational Qualifications (NCVQ) at Level 3 in the national framework and have been made available to Brigades by the Fire Services Awarding Body (FSAB).

The National Council for Vocational Qualifications is now known as the Qualifications and Curriculum Authority (QCA).

The National Vocational Qualification provides the first national qualification which has been specifically designed for fire brigade control personnel. Brigades who do not wish to introduce NVQ's can still use the Standards of Competence based training.

Training for competence enables everyone in the Control Centre to demonstrate, through a system of assessments, against the prescribed standard, that they can consistently and competently perform their work - embracing the 'safe person concept'.

Training for competence provides a framework that offers:

- A systematic method of managing and organising the development, delivery and evaluation of the control personnel training provided by the brigade.
- An objective assessment process that can be used to consistently measure the acquisition of knowledge, skills, attitude and understanding achieved by personnel and teams.
- An objective assessment process that can be used to measure, consistently and continuously, the application of knowledge, skills, attitude and understanding performed by personnel and teams in the workplace.

Brigades can use the functional outcomes contained in these standards to 'role-map' the work and training needs of all watch related control personnel. In total there are 22 functions and 57 elements used to describe the full range of work carried out by control personnel.

Training provided for control personnel should be structured, and delivered, to provide each individual with the knowledge, skills and attitude required to fulfil the functions contained in their role-map. Once the individual has demonstrated that she or he can perform to the standard described in the functional outcomes she or he can be described as competent in acquisition.

In order to ensure that competence is continuously and consistently being applied, a process of continuous work place assessments should be provided. Assessments should be conducted by Watch officers who should routinely assess their staff to ensure that there is a consistent demonstration of competence.

The Standards of Competence should be used for this purpose and, if training needs are identified,

the individual should be given the necessary training, guidance and support. Control personnel should also have access to a library of training modules that detail the learning outcomes required for control related subjects or functions.

Control personnel managers at all levels should also be part of a process of continuous assessment of their role conducted by their line manager(s).

Further guidance on training for competence is contained in the competence framework (Fire Service Circular 15/1997).

APPENDIX 2

List of relevant DCOLs/DFMs (in Scotland) and FSCs

DCOL		DFM
4/1988	=	5/1998
6/1992	=	4/1992
4/1995	=	4/1995
6/1995	=	5/1995
8/1995	=	6/1995
6/1996	=	6/1996
9/1996	=	8/1996
8/1997	=	8/1997
1/1998	=	2/1998

FSC3/1975
FSC15/1997

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